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The Maryland Herpetological Society
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Natural History Society of Maryland, Inc.
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STRIKE-INDUCED CHEMICAL PREFERENCES IN RATTLESNAKES: ROLE OF CHEMICAL CUES ARISING FROM THE DIET OF PREY

Ted Melcer, David Chiszar and Hobart M. Smith

Abstract

Twelve rattlesnakes of the genus Crotalus were observed after striking rodent prey that had been eating one of two diets, pure Purina chow and chow mixed with sage (5% by weight). Envenomated rodents were discarded, and snakes were presented with two nonenvenomated carcasses, one from each diet type. Snakes that struck a rodent that had been eating pure chow preferred the matching test carcass, and the same was true for snakes that struck a rodent from the sage regiment. Hence rattlesnakes register and retain chemical information arising from the prey's diet.

Rattlesnakes frequently strike and release rodent prey which wander some distance before dying (Hayes & Galusha, 1984; Kardong, 1986). The snakes then follow the chemical trail of prey to recover and ingest the struck carcass (Golan et *al.*, 1982). Melcer and Chiszar (1989a,b) showed that rattlesnakes acquire a preference for chemical cues on prey during the predatory strike and this preference guides post-strike searching for at least 1 hour.

The chemical cues applied to prey by Melcer and Chiszar were artificial (e.g., perfumes). Thus, it is important to determine whether rattlesnakes form preferences for chemical cues that prey might acquire under natural conditions. The snakes also showed strike-induced preferences for chemical cues arising from the diet of the prey but again artificial cues were used (cinnamon/cocoa mixed in lab mouse chow). Deer mice (*Peromyscus maniculatus*), a natural prey of prairie rattlesnakes (*Crotalus viridis*), live near and likely feed on sage plants (Duvall, King & Gutzwiller, 1985). Thus it is possible that mice might acquire distinctive chemical identities from eating sage, and the present experiment tested the possibility that rattlesnakes form strike-induced preferences for such diet-based chemical cues.

Method

Twelve rattlesnakes (7 *C. viridis*, 3 *C. horridus*, 1 *C. enyo*, 1 *C. atrox*) were subjects. Snakes were housed and tested individually in glass terraria (50 x 27.5 x 30 cm) and fed small rodents (*Mus musculus* or *Rattus norvegicus*) once every 2 weeks (see Melcer & Chiszar, 1989a for details).

Mice (*Mus musculus*) used as stimuli were housed 4 or 5 to a cage and provided with powdered lab chow or powdered lab chow adulterated with sage (5% by weight) 24 hours before the experiment. No live mice were struck by snakes. They were sacrificed prior to the experiment and all carcasses were eventually eaten by snakes.

Snakes struck the carcass of a mouse that ate sage chow ($N = 6$) or unadulterated chow ($n = 6$). The struck carcass was removed and two minutes later the snake received a choice between two nonenvenomated carcasses: one of a mouse that ate the sage chow and one of a mouse that ate the regular chow. These carcasses were confined to wire mesh bags (13.5 x 5 cm) secured on a wooden base (13.5 x 23, 3.5 cm) to prevent snakes from eating during the 2 min. test. We recorded the time spent and the number of tongue flicks emitted over each of the test carcasses (i.e., when snakes were oriented toward and within 2.5 cm of either carcass).

Results and Discussion

The test carcass with the same dietary cues as those on the stuck carcass was called the matching carcass, and the alternative test carcass was called non-matching. The magnitude of preference for the matching carcass did not differ between snakes that struck a sage carcass and snakes that struck the carcass of a mouse that ate regular chow, $t(10) = 0.357$, $p > 0.10$, so the data were pooled for the analyses presented below.

Snakes emitted significantly more tongue flicks over the matching ($\bar{X} = 38.2$, S.E. = 5.9) than the non-matching carcass ($\bar{X} = 17.6$, S.E. = 4.1, $t(11) = 2.52$, $p < 0.05$) and spent marginally more time over the matching ($\bar{X} = 48.0$ s, S.E. = 8.1) than the non-matching carcass ($\bar{X} = 26.0$ s, S.E. = 6.0, $t(11) = 1.81$, $0.10 > p > 0.05$). Ten of the 12 snakes preferred the matching carcass (6 of 7 *C. viridis* and 4 of the 5 other snakes.)

Rattlesnakes acquire chemical information while striking (Melcer & Chiszar, 1989a,b), and this occurs when chemical differences among prey derive from plants that are sympatric with the snakes and with natural prey. Hence, dietary specialization by individual prey might give rise to distinctive chemical cues that rattlesnakes can exploit during the post-strike trailing and carcass recovery process. We are currently assessing this possibility using deer mice as prey (Furry, Swain & Chiszar, 1989).

Our goal in this project has been to demonstrate whether or not rattlesnakes acquire specific chemical information during predatory strikes. They clearly can do so, at least under our laboratory conditions (see Burghardt, 1977, for a review of learning in reptiles). The extent to which this ability plays a role (sensu Gans, 1986) under natural conditions will remain a matter of conjecture until appropriate field observations are made. Also, no claims can be made about the sensory mechanisms underlying this learning phenomenon until we have data from experiments analogous to those reported for garter snakes by Halpern & Frumin (1979) and Kubie and Halpern (1979).

Acknowledgments

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THE ENDEMIC CORAL SNAKES OF THE LOS TUXTLAS REGION, SOUTHERN VERACRUZ, MEXICO

Gonzalo Pérez-Higareda and Hobart M. Smith

Abstract

The spotted coral snakes of Los Tuxtlas, Veracruz, Mexico, constitute a discrete population parapatric with the ringed population. The two populations are distinguished taxonomically as *Micrurus l. limbatus* (ringed) and *M. l. spilosomus* subsp. nov. (spotted). The only other population of spotted coral snakes in Mexico is regarded as occupying the same relationship to *M. diastema* as *M. l. spilosomus* does to *M. l. limbatus*, and is ranked as a subspecies, *M. diastema bernadi*.

The existence of a distinct species of coral snakes (*Micrurus limbatus*) in the Los Tuxtlas region of southern Veracruz, Mexico, was reported in 1964 (Fraser), and ever since then all *Micrurus* from that area have been referred to either that endemic species or the widespread *Micrurus diastemus* (e.g., Fraser, 1973; Campbell and Lamar, 1989), except for the distinctively patterned *Micrurus elegans*, with triads of black rings. The first report of a spotted instead of ringed *Micrurus* in the Los Tuxtlas region is that of Greene (1973). Illustrations of the spotted snakes have appeared in Greene and McDiarmid (1981) and Campbell and Lamar (1989).

Fifteen years of field work by the senior author in the Los Tuxtlas region indicate that the spotted and ringed chromotypes commonly referred to *M. limbatus* actually are allopatric; the spotted type is known, both in the literature and from material here reported, only from the vicinity of Sierra Santa Marta, and the ringed type only from the vicinity of Volcán San Martín Tuxtla (Fig. 1). The significance of that distribution is evident in comparison of the physical and biological characteristics of the two regions.

One distinction between the two areas is in their soils; according to Sousa (1968), regosols of volcanic ashes characterize the San Martín area, whereas mature, deep red clay latosols characterize the Santa Marta area. Secondly, Holocene climatic differences were great enough to produce extensively different components of vegetational zones (Sousa, 1968); for example, between 600 and 1000 m a.s.l. the forests are predominantly Lauraceae on San Martín, *Liquidambar* (sweet gum) on Santa Marta, and between 1000 and 1150 m *Ulmus americanus* (elm) predominates on San Martín, *Quercus* (oak) on Santa Marta. Similar differences exist at other elevations. Third, San Martín even now is climatically different from Santa Marta, receiving the full brunt of north winds that produce heavier rainfall and greater temperature extremes than in the Santa Marta region with its more moderate, stable climate. Thus the lowlands and isolated hills reflect the individuality that centers upon the higher elevations, resulting in (4) a quite distinctive herpetofauna in the two areas at both high and low elevations. The distinctive San Martín area includes its surrounding lowlands, with Cerro Vigía, San Andrés Tuxtla and Santiago Tuxtla, and the Santa Marta area includes its surrounding lowlands, with Lago Catemaco, Catemaco, Coyame, Tebanca, and Cerro Cintepec.

The distinctiveness of the herpetofaunae of the two areas is conspicuous in comparison of their reptiles. In the San Martín area (including San Andrés Tuxtla, Santiago Tuxtla, Lerdo de Tejada, Isla) *Abronia reidi, Coniophanes bipunctatus biseriatus, C. quinquevittatus, Conophis lineatus, Thamnophis proximus rutiloris, Drymobius chloroticus, Ficimia variegata, Masticophis mentovarius, Sibon fasciata* and *Crotalus durissus* are known to occur, but have never been taken in the Santa Marta area. Similarly, *Laemanctus serratus, Abronia chiszari, Oxybelis fulgidus, Pliocercus bicolor, Sibon dimidiata, Tantilla slavensi, Tantillita lintoni, Tretanorhinus nigroluteus mertensi* and *Trimorphodon biscutatus* have been found in the Santa Marta area, but not in the San Martín area. Some of these species may occur in the area from which they are not now known, but if so they are likely to be less abundant there. For example, *Bolitoglossa platydactyla* is abundant in the San Martín lowlands, rare in the Santa Marta area, whereas the opposite is true of *B. mexicana*.

It is thus obvious that the San Martín and Santa Marta areas are ecologically and faunistically very distinctive from each other. A third area, of Volcán San Martín Pajapan, southeast of Sierra Santa Marta, may well be equally distinctive; it is the only area in the Los Tuxtlas region where *Bothrops asper* and *Crotalus d. durissus* occur in the same habitat, and where *Anolis tropidonotus* and *Scincella gemmingeri* have been taken. Each area is, metaphorically, a distinct island in its zoogeographic archipelago. Therefore we regard the allopatry (or parapatry) of the ringed and spotted populations heretofore referred to *M. limbatus* as of taxonomic significance. We here name the spotted population

Micrurus limbatus spilosomus subsp. nov.

Holotype. UNAM-LT (Universidad Nacional Autónoma de México, Los Tuxtlas) 2733, female (Figs. 2, 3), from Bastonal, Sierra de Santa Marta, 900 m, municipality of Catemaco, Veracruz, Mexico, July, 1985, Gonzalo Pérez Higareda and Oscar Flores Villela.

Paratypes. Five, UNAM-LT 3167-8, adult females, and 3169-71, adult males, topotypes, 900-1000 m, Nov. 1988-Febr. 1989, Gonzalo Pérez-Higareda.

Diagnosis. A member of the species *M. limbatus*, not differing from the nominotypical subspecies, *M. l. limbatus*, in scutellation, but differing from it in pattern, having 14-21 round or oval black spots on a red dorsum; highly irregular, widely spaced blotches on venter; 3-4 black tail rings, shorter ventrally than dorsally; and a nuchal black ring interrupted ventrally or no more than one ventral long (as opposed to 31-45 black rings encircling body; 4-6 black tail rings, longer ventrally than dorsally, nuchal black ring complete, covering 3 or 4 ventrals).

Description of Holotype. Head scales normal; preoculars 1-1; no loreal; postoculars 2-2; temporals 1-1; supralabials 7-7, 3rd and 4th entering orbit; infralabials 7-7. Dorsal scale rows 15-15-15; ventrals 200; caudals 27, all divided; anal divided. Snout-vent length 500 mm; tail length 50 mm; total length 550 mm.

Fourteen large, well-defined, oval or round black spots on dorsum of body posterior to nuchal ring; 10 other, irregular, narrower and smaller spots or points between the preceding. Venter with 11 large, irregular, angular black spots, and several black flecks. Areas between and surrounding black spots red; red areas on venter immaculate, on dorsum with black-edged scales. Tail with three complete black rings, including one at tail tip. Black nuchal ring 4 scales long dorsally, involving one ventral completely and one incompletely.

Variation. The head scales are the same throughout the type series. Including the holotype, the three females have 200-203 ventrals and 27-29 caudals; the three males have 189-192 ventrals, 41-42 caudals.

The black dorsal spots are similar in all, in a single longitudinal series; the main ones are 6-10 scales in length, 4-7 scales in width, number 19-21 in males, 14-15 in females, and most are separated by spaces 10-14 scales long, occasionally less. The dorsal spots do not reach the ventral scales; at least the first two dorsal scale rows separate them. The dorsal scales in the red areas are black-pigmented near their edges, but much less so than in the nominotypical subspecies.

The black ventral spots are highly irregular, asymmetrical and angular in shape, the largest extending over 10-15 ventrals but not reaching their edges. The dorsal and ventral spots do not correspond with each other in position, and are less numerous than the black rings of the nominotypical subspecies. The intervening red areas on the venter are immaculate.

The caudal black rings are four, including the black tail tip, except for the female holotype, with three; all are complete, five scales long dorsally, one or two ventrally.

The light areas of the head are pale red in life, cream in preservative. Black extends from the prefrontals to the center of the parietals, and laterally includes the preocular, part of the supraocular and of the nasals, and the upper half of the first and second supralabials. The edges of the parietals, the posterior part of the supraoculars and the postoculars are slightly darkened with brown. The infralabials and chinshields are immaculate.

The nuchal black ring usually covers four scale lengths, and is narrow ventrally, interrupted or complete on no more than one ventral.

Variation in *M. l. limbatus.* Eighteen specimens are available, including 8 males, 10 females, from: Estación de Biología "Los Tuxtlas" (160 m), UNAM-LT 212, 370, 628, 1578, 2084, 2797, 2798; Laguna Escondida (170 m), UNAM-LT 1332, 1728, 2658; Colonia La Palma (18 m), UNAM-LT 1579, 1693; El Acuyal (650 m), UNAM-LT 1332; Cintepec (500 m), UNAM-LT 2881; Dos Amates (400 m), UNAM-LT 1371-2; Volcán San Martín Tuxtla (1500 m) UNAM-LT 3165, 3166.

Scutellation of the head is invariable, exactly as in *M. l. spilosomus.* The ventrals and caudals respectively are 189-191, 37-42 in males, 198-206, 25-30 in females. There are 31-35 black rings, including the nuchal, all complete, in males, 35-43 in females. The dorsal scales in the intervening red areas are heavily black-pigmented, but the red ventral areas are immaculate.

The nuchal ring is four scales long middorsally, six on sides, 3-4 on venter. The snout is completely black, including the rostral, nasals, prefrontals, frontal, supraoculars, preocular, most of the parietals and supralabials 1-3. Infralabials 1-4 and chinshields black-spotted. The tail rings are complete, 5-6 in males, 4-5 in females. See Figs. 2, 3.

Contrasts. The salient distinction of *M. l. spilosomus* from *M. l. limbatus* is the absence of black rings except for the nuchal and caudal rings, and the presence instead of elongate black spots on both dorsum and venter. Those spots are less numerous (14-21 dorsally) than the rings (31-43) in *M. l. limbatus*, and do not have the appearance of interrupted rings.

In addition, the red scales on dorsum are lightly pigmented with black, the snout is red, and black on head less extensive, the nuchal ring interrupted or narrower ventrally, and the caudal rings tend to be fewer, especially in males.

Taxonomic Status. That the population here designated *M. l. spilosomus* is taxonomically distinct appears to be incontrovertible, inasmuch as it is geographically isolated from its closest relative, is constant in its distinctions, and is correlated with many biological and physical features peculiar to its geographic range. The main questions that do exist concern rank and origin.

M. l. limbatus is characterized not only by a very distinctive pattern, at least in its region, being bicolored instead of tricolored, but also by having fewer ventrals and caudals than the co-existing populations of *Micrurus diastema*. In central Veracruz the ventrals and caudals, respectively, of males are 193-202 and 43-47, of females 211-226, 30-38 (Fraser, 1973). In *M. l. limbatus* those figures are 189-191, 37-42 in males, and 198-206, 25-30 in females. *M.l. spilosomus* likewise has fewer ventrals and caudals than *M. diastema*, agreeing with *M. l. limbatus* in that respect. Derivation from the latter seems highly likely, and the existence of a possibly intermediate specimen from Coyame, a locality intermediate between the San Martín and Santa Marta areas, suggests that the two populations may be parapatric and hence may intergrade. Fraser (1964) described that specimen as having "nearly entire annuli (12) alternating with laterally interrupted annuli (13)" and "a narrower nape ring (3 1/2 to 4 scales wide)." Presumably none of the black rings are really complete ("*nearly* entire"), they are broken laterally (as would be expected if the separate dorsal and ventral spots of *M. l. spilosomus* were derived from the rings of *M. l. limbatus*), and the nuchal ring is shorter, as in *M. l. spilosomus*. It is therefore our conclusion that the spotted population of the Santa Marta region was derived from and is subspecifically related to the ringed population of the San Martín region.

The Status of *Micrurus bernadi*. The only other population of coral snakes in Mexico characterized by a spotted pattern has been recognized as *M. bernadi*. As described and figured by Campbell and Lamar (1989), that population differs from *M. l. spilosomus* in having more numerous dorsal spots (24-42, vs 14-21) that appear to be remnants of black rings interrupted ventrally (rather than laterally), very few black ventral marks, and more numerous ventrals (203-228, vs 189-203).

Curiously, the same relationship exists in number of ventrals in *M. bernadi* and adjacent *M. diastema* as in *M. l. spilosomus* and *M. l. limbatus*: they are the same. This parallelism suggests that *M. bernadi*, with its distinctive geographic range, is a derivative and subspecies of *M. diastema*, from which it differs in no way except pattern. We here propose that its taxonomic relationships are properly expressed as another subspecies of that highly polytypic species: *M. diastema bernadi*. It is of considerable corroborative interest to note that *M. diastema* is highly variable in pattern; although much is correlated geographically, the ringless specimens reported by Blaney and Blaney (1979) may not be. They at least indicate a genetic capacity in the species to produce as aberrant a pattern as in *M. d. bernadi*.

Etymology. The name *spilosomus* is proposed as an adjective derived from the Greek words transliterated as *spilo*, meaning spot or spotted, and *somus*, meaning body.

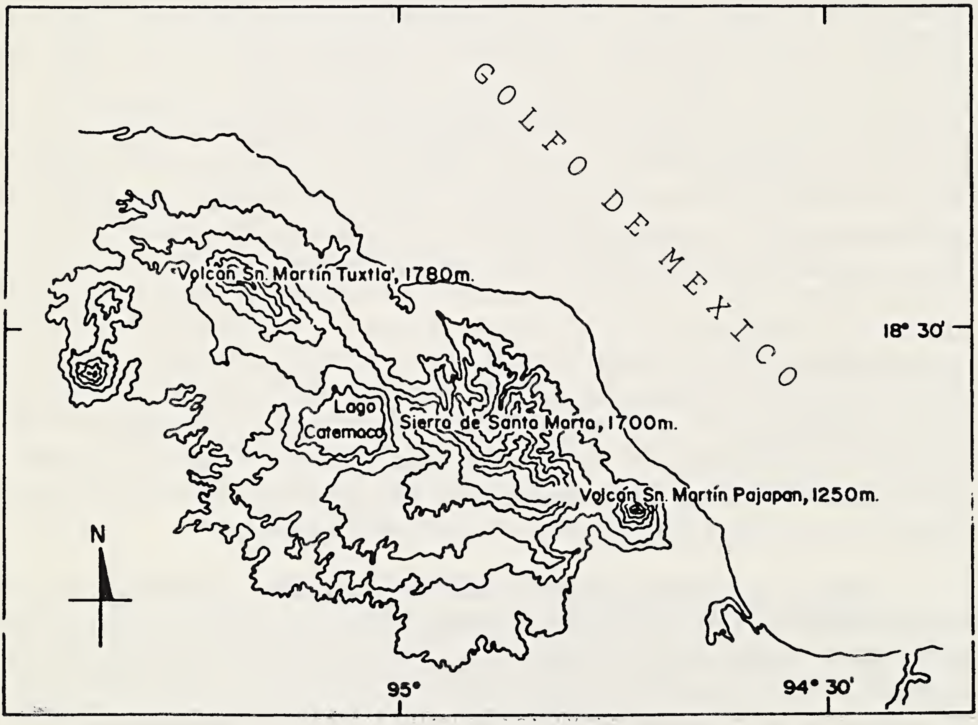
GOLFO DE MEXICO
Volcán Sn. Martin Tuxtla', 1780m.
18° 30'
Lago Catemaco
Sierra de Santa Marta, 1700m.
Volcán Sn. Martin Pajapan, 1250m.
N
95°
94° 30'

Fig. 1. The Los Tuxtlas region, southern Veracruz, Mexico. Contour intervals 250 m. After Flores et al. (1987).

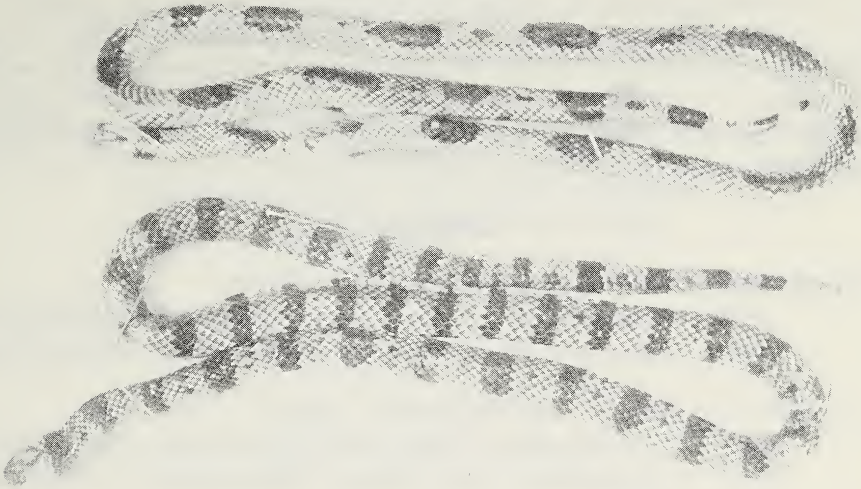

Fig. 2 Dorsal views of *Micrurus limbatus spilosomus* (above), holotype, UNAM-LT 2733, Bastonal, Sierra de Santa Marta, 900 m, Veracruz, Mexico, 550 mm s-v; and *M. l. limbatus* (below), Volcán San Martín Tuxtla, 1500 m, Veracruz.

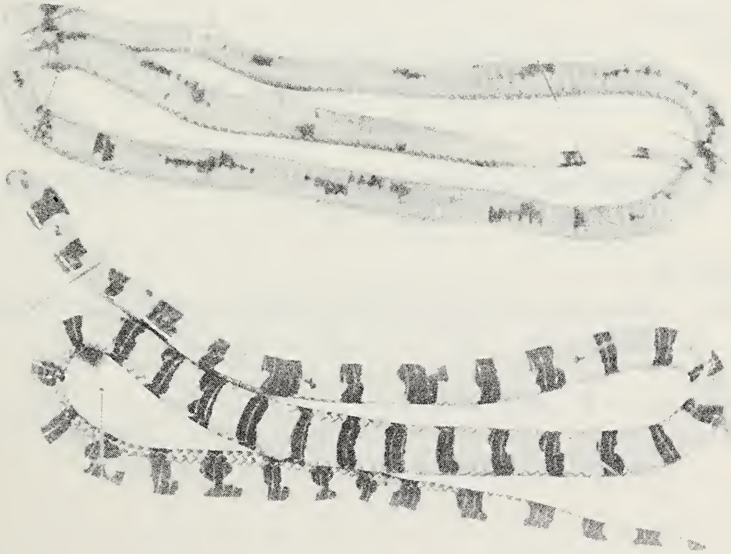

Fig. 3. Ventral views, as in Fig. 2.

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UNICOLOR HATCHLING COLORATION IN A POPULATION OF THE LIZARD *SCELOPORUS UNDULATUS CONSOBRINUS* IN SOUTHEASTERN ARIZONA

Hobart M. Smith and Carl E. Bock

Abstract

Upon hatching, *Sceloporus undulatus consobrinus* in Santa Cruz Co., southeastern Arizona, are completely uniform gray-brown in color, with no markings evident whatever. Within two months the normal pattern of light dorsolateral stripes and dark spots between is clearly defined. In no other subspecies or population of *S. undulatus* are newly hatched juveniles known to be unicolor.

In all subspecies of *Sceloporus undulatus* (Bosc and Daudin), the young have been described as having essentially the same pattern as adult females, although they may be lighter or darker (e. g. Ashton and Ashton, 1985:79; Conant, 1951:22; McCauley, 1945:31). The discovery that fresh hatchlings of *S. u. consobrinus* are unicolor is thus of special interest.

Four hatchlings, of which a captured specimen (CUM 56070) is 21 mm s-v, were observed at the East Corrals on the Audubon Research Sanctuary 10 km SSE Elgin, Santa Cruz Co., AZ, 15-16 Aug 1989. All were uniform gray-brown, with no evidence whatever of pattern even under magnification. Three were in close proximity to each other, hence may well have hatched from the same clutch, but the other was about 25 m away. Another specimen (CUM 56100), 28 mm s-v, was taken 14 Oct. 1989 under the same railroad ties where a unicolor hatchling was caught and released earlier, but this one has the typical, basic adult pattern and color, with dorsolateral light lines between which there are two longitudinal rows of dark spots. In overall appearance the second hatchling appeared dull when captured, not conspicuously marked, but under the microscope the markings are clear although not well developed.

Smith (1946:217) noted that, in *S. u. consobrinus*, "some rare specimens show no dorsal pattern whatever, and are a uniform light brown above." No other reference have we found in the literature to unicolor individuals in any subspecies of *S. undulatus*, although we are aware that old male *S. u. elongatus* of the isolated population on the North Platte River of southern Wyoming (Hammerson and Lapin, 1980) are occasionally almost unicolor greenish gray, apparently through reduction of the pattern present in earlier stages.

Whether the unicolor individuals referred to by Smith (1946) are juveniles or adults is unknown, leaving unresolved whether the unicolor condition is genetically fixed throughout life in some individuals, or is attained occasionally in late ontogeny, or is characteristic throughout the subspecies of freshly hatched individuals that subsequently develop the normal pattern, or is a rare or localized condition of fresh hatchlings.

Since all four of the hatchlings seen on 15-16 August on the Audubon Research Sanctuary were unicolor, and another taken two months later at exactly the same spot had clear evidence of pattern, even though not well developed, we suggest that at least in southeastern Arizona the fresh hatchlings of *S. u. consobrinus* are *usually* if not always unicolor, and that the typical adult pattern (as exemplified by an adult, CUM 56071, from the northern boundary of the Research Sanctuary, about 2 km N of the East Corrals where the juveniles were seen and collected) develops gradually after a few weeks. Further observations are needed, however, to establish definitively the significance of those here recorded, and of Smith's (1946) comment.

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A RECORD BROOD FOR THE SOUTHERN COPPERHEAD, *AGKISTRODON C. CONTORTRIX* LINNAEUS

An adult female copperhead, *Agkistrodon c. contortrix*, was collected on 8 May 1988 by Gene and Marion Kennedy near False River at Jaureau on Hwy. 414, Pointe Coupee Parish, Louisiana (about 15 miles northwest of Baton Rouge). Shortly thereafter, Gene donated the snake to me. Not knowing that the animal was gravid at the time of capture, and leaving shortly after receiving it for a 14 week vacation, it was a surprise to find upon my return home on 26 August, 16 neonates in the aquarium with the mother. The young were born on the evening of 8 August or the morning of 9 August according to Jeff Tamplin, who took care of my snakes while I was out of town. This is considerably earlier than the range of parturition dates for five Louisiana specimens given by Clark (1949) of 10 September to 4 October (average date = 20 September), but within the range of dates of 3 August to 6 November given by Fitch (1960) for the species. Clark (1949) mentioned five well-developed and viable young being removed from a female on 14 August and stated that they would have been born "within a few days at most."

The brood is one of the largest ever recorded for the species. While Clark (1949) reported the brood size for Louisiana specimens as five to ten, Fitch (1960) stated the maximum number of young in *Agkistrodon contortrix* to be 14 — with a possibly valid record of 17 based upon Hook (1936), cited in Wright and Wright (1957, 1962). However, White (1979) described a brood of 21 (one of which died) *Agkistrodon c. mokeson* from Ohio, which appears to be the record for the species.

On 28 August, three weeks after birth and not having yet been fed, a neonate (arrow in figure 1) cannibalized one of its siblings, leaving 15 snakes. Unwilling to kill the snakes for voucher specimens, I had Kelly Swing photograph the remaining young on 30 August (see figure) and on 5 September the 11 surviving snakes were released into the wild. Four of the young died in the intervening period, apparently from starvation, and were preserved in the L.S.U. Museum of Natural Science. Their data, along with those of the mother, are presented in Table 1; scale counts of the mother, since she is still alive, were taken from a shed skin.

Table 1. Data on female and four neonates of *Agkistrodon c. contortrix.*

	Mother	LSUMZ 47914	LSUMZ 47915	LSUMZ 47913	LSUMZ 47916
Snout-vent length	~750 mm	195 mm	200 mm	195 mm	202 mm
Tail length	~100 mm	35 mm	35 mm	40 mm	39 mm
Overall length	~850 mm	230 mm	235 mm	235 mm	241 mm
Tail/LOA	~11.8%	15.2%	14.9%	17.0%	16.2%
Sex	female	female	female	male	male
Dorsal scale rows	29-23-21	29-25-21	31-25-21	28-23-21	31-23-21
Ventrals	143	142	146	139	147
Subcaudals	45	45	47	50	50
Body crossbands	14	14	14	13	14

The snout-vent length of newborn young varies from 203–264 mm in normal individuals, averaging 223 mm in males and 219 mm in females, with stunted litters averaging 194 mm and 190 mm, respectively (Fitch, 1960). Fitch (pers. comm.) states that these young are undersized and cites either the large litter size or lack of food for the mother during pregnancy as possible causes. I thank both Jeffrey Tamplin and C. Kelly Swing for their interest and assistance, and Henry Fitch for reviewing the manuscript.

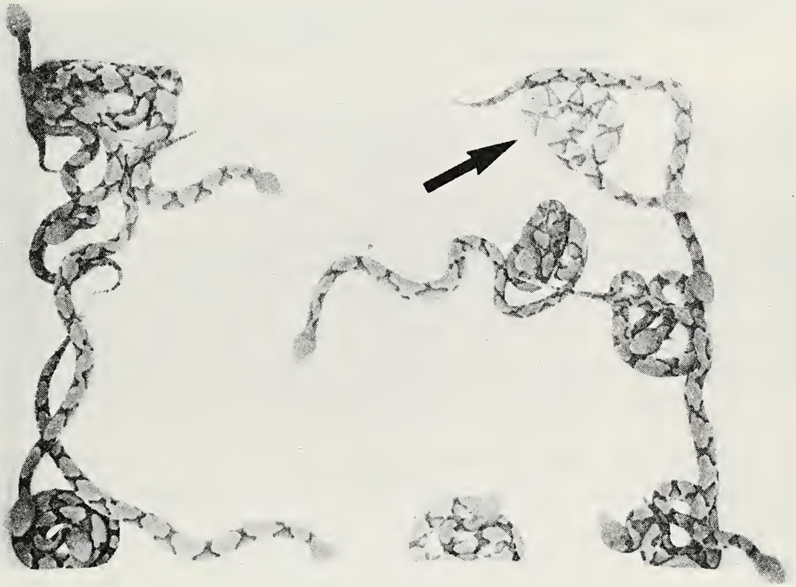

Fig. 1.

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—Van Wallach, *835 Azalea St. #1, Baton Rouge, LA 70802*

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Accepted: 11 December 1989

NEWS & NOTES:

IN DEFENSE OF TODAY'S NOMENCLATURAL PROCEDURES IN ZOOLOGY

In view of repeated attempts to discard modern nomenclatural procedures in zoology, substituting any of a wide variety of alternative procedures (see discussion in Mayr, 1969: 344-346), reflections on the place of current standards are in order.

The goal of the International Code of Zoological Nomenclature has always been to promote and maintain stability and uniqueness of zoological nomenclature. Methods utilized to achieve that goal have evolved tremendously since Linnaeus' time; they have repeatedly been adapted to the innumerable problems that have arisen as knowledge of zoodiversity has increased. That the methods have become more refined (hence complex) as time passes is to be expected, although the procedural problems they are meant to correct now arise infrequently and are of progressively less moment; the major problems have been resolved. Refinements will continue to be made, but they will be of progressively narrower scope.

Certainly the current nomenclatural system is not perfect, but perfection is not humanly possible. The faults of the system *can* be corrected, for the most part. But the beauty of the system is its adaptability to preponderant need in any given case; here the problems are human, not systemic, and will beset *any* system: (1) long delays in action, in many cases, by our nomenclatural court (the International Commission on Zoological Nomenclature), and (2) occasional failure of concerned experts to agree on what is the most desirable solution in any given case. One reason the Commission is so slow to act is that it attempts to satisfy majority wishes. Far from being autocratic, the commission is strongly democratic, thereby suffering the same inefficiency of any democratic effort. The alternative is the whims of autocracy, and who wants it? Not the rank and file taxonomist.

Shifting to another nomenclatural system, after witnessing all of the improvements made in the past in our present system, risks the chaos that we have so far diligently skirted. We do not now operate with a Linnaean system of nomenclature, buried in outmoded simplicity. The main thing that remains of the system that Linnaeus popularized is its binomiality. The principle of priority that is the focus of so much criticism is merely a common-sense, highly practical and desirable *underlying* premise of modern nomenclature; when application of that principle threatens stability or universality, it is readily waived. The waiver practiced in zoological nomenclature is a profoundly beneficent model of a route in which civil law has long been woefully deficient, in its derailed course to justice.

Yet it is wrong to suppress any new idea. Presentation of new nomenclatural systems should not be banned, but in the interest of objectivity they should be clearly and fully stated, with all of their attributes, methods and principles, and with clear statements about how each provision will be superior to those of the present Code. Without such an explanation, no alternative can be evaluated adequately by anyone.

Stability and universality in nomenclature are far more precious achievements, even if some imperfections exist, than should be permitted to be jeopardized by adoption of a new system, without absolute security that improvement will result.

Furthermore, our current system appears to be fully equal to the challenge of the vast numbers of new taxa that may be discovered in the future, no matter how distant. Utter simplicity cannot be expected to go hand in hand with the overwhelming complexity that the future portends. However simple a new system may be, it will have to resolve the same problems, many unanticipated, that our current system has already resolved. A seemingly forward step can easily prove to be a catastrophic step backwards, and therefore should be approached with the utmost caution. Modern nomenclatural procedure has not, as often accused, simply perpetuated a long-outmoded Linnaean system whose demise was forecast long ago and is still anticipated by some would-be iconoclasts; they overlook the dramatic evolution that has gradually taken place in the system and that continues today. Indeed, the Linnaean system *has* demised, replaced through the cultural equivalent of stasipatric evolution, not by competitive exclusion; the latter appears to be totally unnecessary and unwise. The epithet "Linnaean nomenclature" is a degrading and inaccurate titular burden, linked with outmoded antiquity, with which modern zoological nomenclatural procedures should no longer have to contend.

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—Hobart M. Smith, *Department of Environmental, Population and Organismic Biology, University of Colorado, Boulder, Colorado, 80309-0334*; and David Chiszar, *Department of Psychology, University of Colorado, Boulder, Colorado, 80309-0345.*

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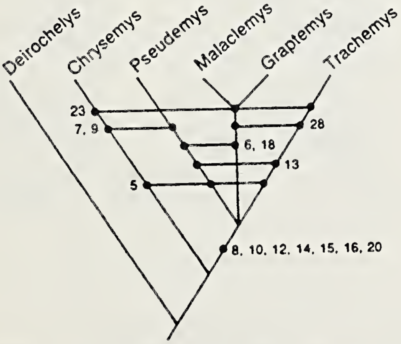

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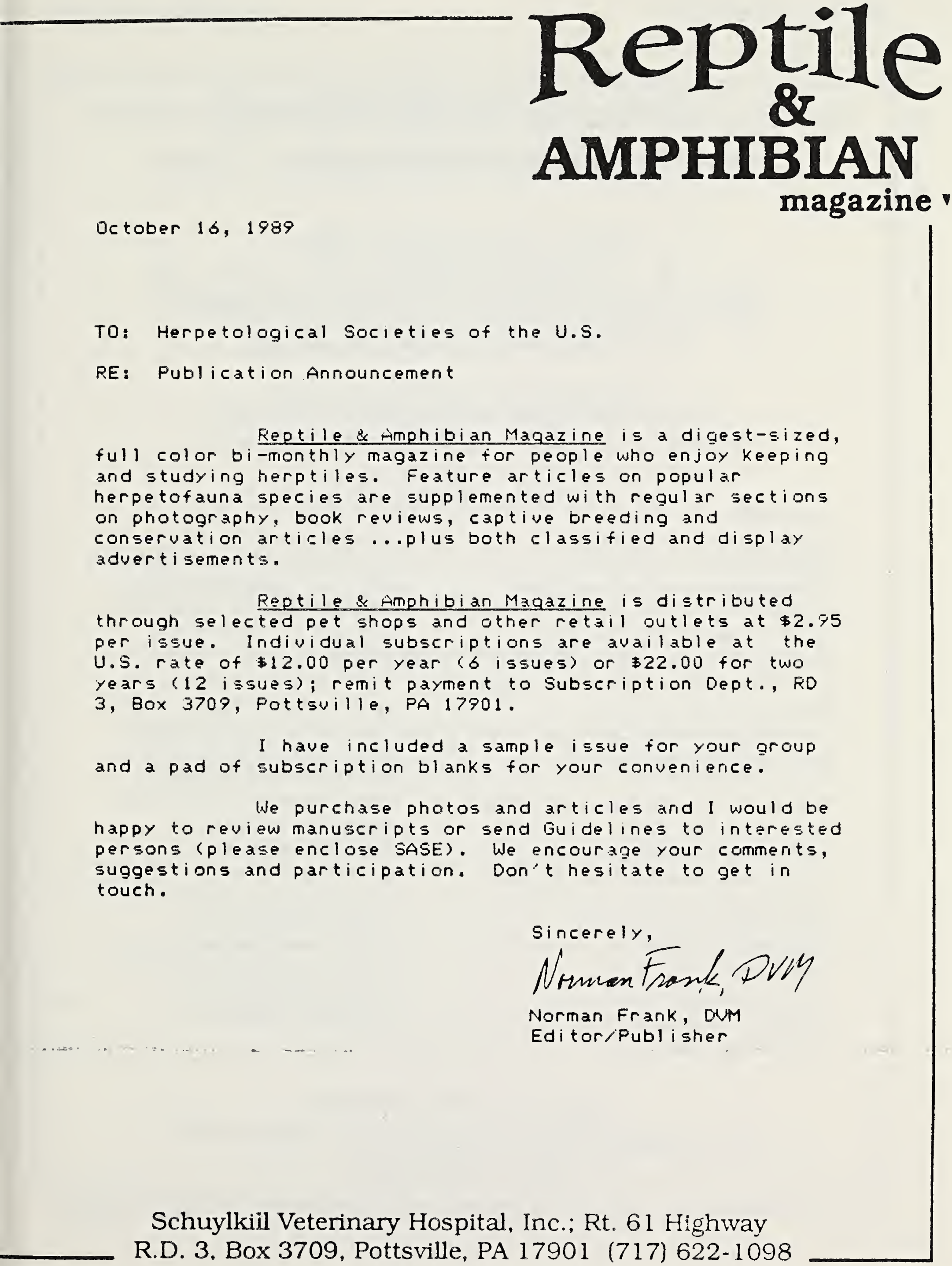

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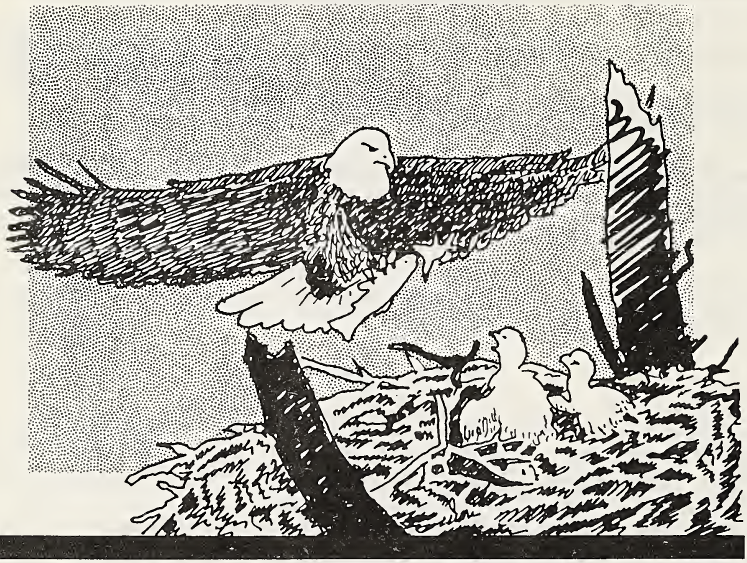

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13TH. ANNUAL ALL FLORIDA HERPETOLOGICAL CONFERENCE-APRIL 21, 1990

The All Florida Herpetological Conference is cosponsored by the Florida Museum of Natural History and the Gainesville Herpetological Society. The conference will be held Saturday, April 21 at the Reitz Union Auditorium on the campus of the University of Florida in Gainesville. Late registrations are accepted starting at 8 a.m. the day of the conference, but we prefer that you preregister using the form below.

Morning speakers will be Harvey Lillywhite, University of Florida, Gainesville; William Magnusson, Instituto Nacional de Pesquisas de Amazonia, Manaus, Brazil; Johan Marais, Assagay Safari Park, Union of South Africa, and Jay Savage, University of Miami, Coral Gables, Florida. Afternoon speakers will be David Barker, Gladys Porter Zoo, Brownsville, Texas; Bob Clark, Oklahoma City; Don Hamper, Columbus, Ohio; John Kaufmann, University of Florida, Gainesville; and Robert Zappalorti, Beachwood, New Jersey. The program starts at 9 a.m.

Other events include a Workshop for Young Herpetologists led by Patricia Ashton, Morningside Nature Center, Gainesville; exhibitors selling herpetological books, art, and other items; and an evening barbeque and auction at the Florida Museum of Natural History.

DIRECTIONS: From the intersection of State Road 26 (University Avenue) and U.S. 441 (S.W. 13th. Street), go south on U.S. 441 (University of Florida campus on your right) until you reach Museum Road (S.W. 8th. Avenue). Turn west (right) onto campus and proceed less than one-half mile. Reitz Union is the flat multi-storied building on your right, past Newell Drive where the museum is located and just past McCarty Drive. You can park in any designated spot. The auditorium is on the third floor of Reitz Union (follow the All Florida Herpetological Conference signs).

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NEWS & NOTES:

SYPOSIUM ON TURTLES AND TORTOISES

Conservation and Captive Husbandry
August 9-12, 1990
Chapman College, Orange, California

PARTICIPANTS AND TOPICS

KEYNOTE SPEAKER: PETER C. H. PRITCHARD, Ph.D.
STATUS OF THE ENDANGERED TURTLES OF THE WORLD

JOHN BEHLER, NEW YORK ZOOLOGICAL SOCIETY:
ST. CATHERINE'S ISLAND CONSERVATION PROJECT

KRISTIN BERRY, PH.D., U.S. BUREAU OF LAND MANAGEMENT:
DESERT TORTOISE CONSERVATION

JAMES BUSKIRK, CHELONIAN RESEARCHER:
PACIFIC POND TURTLES

MARYDELE DONNELLY, CENTER FOR MARINE CONSERVATION:
SEA TURTLE CONSERVATION

GREG GEORGE, RHODE ISLAND ZOO:
MAP TURTLE CONSERVATION/CAPTIVE HUSBANDRY

MIKE GOODE, COLUMBUS ZOO:
CAPTIVE REARING OF JUVENILE TURTLES

JAMES HARDING, MICHIGAN STATE UNIVERSITY MUSEUM:
WOOD TURTLES

DENNIS HERMAN, ZOO ATLANTA:
CAPTIVE HUSBANDRY OF THE EASTERN *CLEMMYS* GROUP

JAMES JUVIK, PH.D., UNIVERSITY OF HAWAII-HILO:
TORTOISE CONSERVATION IN MADAGASCAR

CHARLES LOWE, PH.D., UNIVERSITY OF ARIZONA:
DESERT TORTOISE ECOLOGY IN ARIZONA/SONORA, MEXICO

CRAIG MacFARLAND, PH.D., CHARLES DARWIN FOUNDATION:
GALAPAGOS TORTOISE CONSERVATION

SEAN McKEOWN, FRESNO ZOO:
ASIAN BROWN TORTOISE CONSERVATION AND BREEDING

DAVID MORAFKA, PH.D., CSU DOMINGUEZ HILLS:
BOLSON TORTOISE CONSERVATION

HANS-DIETER PHILIPPEN, GERMAN CHELONIAN SOCIETY:
ASIAN EMYDIDS

PETER C.H. PRITCHARD, PH.D., FLORIDA AUDUBON SOCIETY:
THE SIDENECK TURTLES OF AUSTRALIA

WALTER ROSSKOPF, D.V.M.:
RESPIRATORY DISEASE IN THE DESERT TORTOISE

MICHAEL RUGGE, SEA TURTLE CENTER:
THE LEATHERBACKS OF MICHOACAN

BERN TRYON, KNOXVILLE ZOO:
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HAROLD WAHLQUIST, PH.D., U.S. FISH & WILDLIFE SERVICE:
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SYMPOSIUM SCHEDULE

Thursday August 9
4:00 p.m. - 9:30 p.m. Registration/Open House
Ice Breaker: Walter Allen's Casa de Tortuga

Friday August 10
8:00 a.m. - 5:00 p.m. Registration/Presentations
7:00 p.m. - 9:00 p.m. Workshops - Exotics/Aquatic & Box

Saturday August 11
8:30 a.m. - 4:00 p.m. Presentations
4:00 p.m. - 5:30 p.m. Workshop - Desert Tortoise

BANQUET
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Saturday, August 11, 6-10 p.m.

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"The Making of the Movie: Turtles of the World"

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Back issues of the Bulletin of the Maryland Herpetological Society, where available, may be obtained by writing the Executive Editor. A list of available issues will be sent upon request. Individual numbers in stock are $2.00 each, unless otherwise noted.

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Information for Authors

All correspondence should be addressed to the Executive Editor. Manuscripts being submitted for publication should be typewritten (double spaced) on good quality 8 1/2 by 11 inch paper with adequate margins. Submit original and first carbon, retaining the second carbon. If entered on a word processor, also submit diskette and note word processor and operating system used. Indicate where illustrations or photographs are to appear in text. Cite all literature used at end in alphabetical order by author.

Major papers are those over 5 pages (double spaced, elite type) and must include an abstract. The authors name should be centered under the title, and the address is to follow the Literature Cited. Minor papers are those papers with fewer than 5 pages. Author's name is to be placed at end of paper (see recent issue). For additional information see *Style Manual for Biological Journals* (1964), American Institute of Biological Sciences, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016.

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Natural History Society of Maryland, Inc.
2643 North Charles Street
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JUNE 1990

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Volume 26 Number 2 June 1990

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The Maryland Herpetological Society
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Natural History Society of Maryland, Inc.
2643 North Charles Street
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BULLETIN OF THE

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Volume 26 Number 2 June 1990

The Maryland Herpetological Society
Department of Herpetology, Natural History Society of Maryland, Inc.

Executive Editor............Herbert S. Harris, Jr.

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Meetings

The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May—August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

RELATIONSHIP BETWEEN REPRODUCTIVE MODALITY AND ELEVATIONAL DISTRIBUTION OF THE *SCELOPORUS AENEUS* COMPLEX (SAURIA: IGUANIDAE) IN THE STATE OF MÉXICO, MÉXICO

José L. Camarillo R.

Abstract

Data on elevational, geographic distribution and reproductive modality in the *S. aeneus* complex in the state of México, lend strong support to the "cold climate" hypothesis as the most likely cause for origin of viviparity in certain populations of *Sceloporus aeneus*. These data also indicate that viviparity appeared independently at least twice in these mountainous populations. Existence of a placenta in both *S. bicanthalis* and *S. subniger* suggest that that character emerged as a concomitant or consequent adaptation to viviparity.

The *Sceloporus aeneus* complex is widely distributed in central México (Guillette and Smith, 1985). Until 1974 three subspecies were recognized from this region: *S. aeneus aeneus*, *S. aeneus bicanthalis* and *S. aeneus subniger* (Smith, 1937, 1939; Poglayen and Smith, 1958; Davis and Smith, 1953; Smith and Hall, 1974). However, a statistical study by Thomas and Dixon (1976) indicated that no significant differences in pholidosis exist among these purported subspecies, all of which they synonymized with *Sceloporus aeneus*.

The situation so remained for about five years, when Guillette's studies (1981a, b, 1982) confirmed the existence of two species: *Sceloporus aeneus* and *Sceloporus bicanthalis*. The existence of two reproductive modalities permitted separation into well defined species (Guillette , 1981a).

The third subspecies (*S. aeneus subniger*) was briefly analyzed but its taxonomic situation was not clarified. Later, however, Guillette and Smith (1985) interpreted all three taxa as full species on bases of coloration, scutellation and data on reproduction.

In this note, I indicate the relationship between reproductive modality and elevational distribution of the 3 species in the state of México and discuss implications relative to the "cold climate" hypotheses of origin of viviparity in the species.

Methods

Data on elevational distribution and habitat of the *Sceloporus aeneus* complex in the state of México were compiled by consulting the herpetological collections of the Instituto de Biología (IBH), and Escuela Nacional de Estudios Profesionales Iztacala (CH-ENEPI), UNAM, as well as by examining the related literature, and performing field studies. The latter activity was carried out during 1979, in Cahuacán, Transfiguración, and Villa del Carbón (Ramírez *et al.* 1980); Huitzilac, Mor.-La Ladrillera, Edo. de México transect (Camarillo, 1981); the Calimaya-Nevado de Toluca area in 1983; and during January-July, 1985, only on the Nevado de Toluca. Additional collections at Valle de Bravo, Tenango del Valle, Zoquiapan and Popocatépetl were made in 1985-1986.

In order to verify reproductive modality of collected specimens, dissections were made in the laboratory; for the purpose of this study, lizards were considered oviparous if uterine eggs were present, or viviparous in the presence of embryos (see Fig. 1 in Guillette, 1981b). Hence, the terms oviparity and viviparity are used in the same sense as in Shine (1985), Guillette (1987) and Smith (1987), as determined by the presence of placental structures, as in *Sceloporus bicanthalis* and *S. subniger* (Guillette, 1981b; Baiza and Camarillo, 1986), or their absence. No attempt to determine embryonic development or reproductive cycle was made except for *S. subniger* (Camarillo and Díaz, 1987).

For identification, three criteria were used: 1) ventral color pattern (Guillette and Smith, 1985); 2) scale numbers and morphology (Smith, 1939; Poglayen and Smith, 1958; Guillette and Smith, 1985); and 3) type locality or just locality. All specimens are now in the herpetological collection of ENEPI, but later a portion of them will be donated to the Instituto de Biología, UNAM.

Results

1. Elevational distribution and habitat of the *Sceloporus aeneus* complex in the state of México.

Sceloporus aeneus is an oviparous lizard having a narrow elevational range: 2000-3000 m (Table 1), but it occurs in an extensive geographical zone with different types of vegetation, such as pine, pine-oak, fir, and oak forests as well as in farmed fields and occasionally in alpine grassland (e.g. at Lagunas de Cempoala, Edo. de México). As a whole, the region occupied by this species shows some variation of a temperate climate (Fig. 1).

Sceloporus bicanthalis, on the contrary, is viviparous and occurs through a wider elevational range of 3000-4000 m in the Zoquiapan-Popocatépetl region only; it inhabits basically pine, fir-pine, and fir forests or the alpine grassland zone (e.g. at Popocatépetl, Edo. de México-Puebla). In this region the climate is cold (Fig. 2).

Finally, *Sceloporus subniger* is also a viviparous species, has an elevational range of 3000-4500 m, occurs only on the Nevado de Toluca, and inhabits primarily alpine grassland and pine forest. In this zone the climate is cold (Fig. 3).

2. Reproductive modality-elevational distribution relationship.

The *Sceloporus aeneus* complex, widely distributed in the state of México, inhabits more than 40% of the temperate region of the state and occurs in several distinct habitat types, with an elevational distribution of 2000-4500 m; reproductive modality is closely correlated with elevational range. Between 2000 and 3000 m only oviparous populations occur, although in spite of their limited vertical distribution they occur more widely than the viviparous populations (Table 1); for example, the distance between one locality extreme (Cahuacán) of the range of *Sceloporus aeneus* and the opposite extreme (Col. G. Báz) is ca. 60 km. Only viviparous populations occur between 3000 and 4500 m - a greater elevational range but a more restricted horizontal range (Fig. 4).

The described situation in points 1 and 2 appears to indicate that at least in the state of México the neovolcanic axis mountains function as "island" in their higher portions (3000-4500 m) for members of the *Sceloporus aeneus* complex; in these "islands" viviparity is favored. Probably this phenomenon also occurs in other populations of this complex at high elevations throughout central México; scattered data in the literature report only oviparous populations in lower zones (Sánchez-H., 1981; Guillette, 1981a; Guillette and Smith, 1985; Duellman, 1961), but more information on this topic is needed.

3. Implications of reproductive modality-elevational distribution relationships relative to the "cold climate" hypothesis as applied to the *Sceloporus aeneus* complex.

Guillette's studies (1981a, b, 1982) establish that cold climate is a factor promoting existence of viviparity in the *Sceloporus aeneus* complex. However, other alternatives might explain the origin of that reproductive modality (Shine, 1984). But among the different hypothesis proposed to explain the appearance of reptile viviparity (Blackburn, 1982; Packard *et al.*, 1977; Shine and Bull, 1979), the arguments for the "cold climate" hypothesis (Shine, 1984) accord very well with our own observations, in turn supporting Guillette's (1981a, b, 1982) and Shine's (1985) propositions.

This hypothesis posits that there is a very close association between the distributional pattern of viviparity and the cold climate of high latitudes or elevations (Shine, 1984, 1985). The facts (1) that *Sceloporus subniger* is also a viviparous form at high elevation, but in a zone distinct from that of *Sceloporus bicanthalis*, and (2) that the geographic distribution of the three species is highly correlated with the oviparity-viviparity elevation gradient (Fig. 5) are arguments supporting the hypothesis that cold climate environment, in this case due to high elevations, has had an important role in the development of viviparity in the *Sceloporus aeneus* complex. Environmental and ecological conditions of the past and present, coupled with higher elevations, promoted the appearance of viviparity in this lizard group, as been suggested by Guillette (1981a, b, 1982) and several others concerned with the origin of viviparity in general in reptiles (Shine, 1984; Packard *et al.* 1977). Nevertheless, more detailed studies centered about these islands are needed to clarify further what ecological conditions have favored viviparity. If there really is a gradation in parity the transition zone (with intergradation or perhaps hybridization) would be expected at an altitude of about 3000-3500 m, at least in the state of México. In such sites the dynamics of the process might be analyzed, if it is ongoing.

Discussion

Our data definitively support the "cold climate" hypothesis as a decisive factor in the appearance of viviparity in the *Sceloporus aeneus* complex. I suggest that for this same reason, viviparity originated independently at least twice in the populations of this lizard at state of México: once in the Zoquiapan-Popocatépetl area, and again in the Nevado de Toluca zone. The arguments that lead us to propose this idea follow. 1). Oviparous populations of *S. aeneus* inhabit a wide geographic zone of the state of México (and perhaps this modality applies as a general rule throughout central México), at low elevation (ca. 2000-3000 m), whereas viviparous populations are localized in very specific regions at high elevations (ca. 3000-4500 m). This relationship is in agreement with the premise that oviparity is a plesiomorphic feature and viviparity was derived from it (apomorphic; Fitch, 1970; Blackburn, 1982, 1984).

If the *S. aeneus* complex had been originally viviparous throughout its entirety, including populations at elevations lower than 3000 m, that reproductive modality would be dominant. Such a possibility is documented by the present distribution of 4 viviparous species of the same genus in the state of México, within an elevational range from 1800 to 4500 m: *S. t. torquatus* (Camarillo, 1981; Feria, 1986), *S. mucronatus* (Alvarez y Huerta, 1973; Mendez y Villagrán, 1983); *S. grammicus microlepidotus* (Guillette and Casas-A., 1980) and *S. jarrovi* (3000 m; Camarillo, 1981). No oviparous populations of *Sceloporus* occur in that range of distribution. On the other hand, 4 oviparous species of the same genus (*S. spinosus*, *S. scalaris*, *S. pyrocephalus* and *S. horridus*) occur below 3000 m in the state. Therefore, the elevational distribution of these 8 species accord with the points indicated by Guillette *et al.* (1980): a) once the trait of viviparity has evolved, it is irreversible; b) species radiation from a viviparous stock leads to forms adapted to lowland habitats except that viviparous species there would be limited to fewer broods per season than lowland oviparous species. However, no known viviparous population of the *S. aeneus* complex inhabits lower elevations; hence it presumably was primitively oviparous.

2) Two important events affected distribution and biology of the biota of México during the Pleistocene: cyclic oscillations of the climate (Toledo, 1976) and the emergence of the mountain systems of the neovolcanic axis (López, 1980; Demant *et al.*, 1976; Mooser, 1975). Since high elevation areas seem to function as "islands", the latter event could have had an important role in the appearance of viviparity in the *Sceloporus aeneus* complex. The following scenario is hypothetical but consistent with available information.

In the Pleistocene, the genus *Sceloporus*, already established in tropical and semitropical zones of México (Ballinger and Tinkle, 1972), populated mountainous regions as those became available in the central area (geological data from Mooser, 1975; Demant *et al.*, 1976). In the process, certain ancestral, pre-*S. aeneus* populations became adapted to high elevations, evolving as viviparous *S. bicanthalis*.

The Nevado de Toluca volcano, it is estimated, originated approximately 25 thousand years ago, and its last violent explosion occurred 11 to 25 thousand years ago (Bloomfield, 1974). Colonization of the zone by pre-*S. aeneus* populations presumably gave rise to viviparous populations a second time, in the form of *S. subniger*. Differentiation of that taxon must therefore occurred in relatively recent geological times.

Data on elevational and geographic distribution, as well as those on reproductive modality in the *S. aeneus* complex in the state of México, give strong support to the "cold climate" hypothesis as the most likely cause for origin of viviparity in certain populations of the species, as suggested by Guillette (1981a, b). Moreover, these data seem to indicate that viviparity appeared independently at least twice in the mountainous populations of the state. Also, very importantly, the existence of a placenta in both *S. bicanthalis* and *S. subniger* suggest that that character emerged as a concomitant or consequent adaptation to viviparity, as pointed out by Jones (1987).

Studies concerning physiological and embryonic development (Shine, 1984), reproductive strategy (Guillette, 1981b), generic structure of populations and basal metabolism, can yield valuable information to better understand the "protoadaptations" as well as the morphological and physiological changes in the *S. aeneus* complex leading to viviparity and placental formation. If some zone really exists with well defined oviparity-viviparity gradient populations, they would be in the process of transition. At this moment no contact between *S. bicanthalis* and *S. aeneus* in the Zoquiapan-Popocatépetl area has been detected (Guillette and Smith, 1985), but possible contact zones there and elsewhere, especially in the vicinity of the Nevado de Toluca, are much in need of intensive field and laboratory study.

Acknowledgments

I wish to thank Drs. H.M. Smith, L.J. Guillette and F. Rivera for help with and comments on this note. The work was supported by a grant from CONTACyT, ICECXNA 060345, D.F. México.

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Table 1. Elevational distribution of the *Sceloporus aeneus* complex in the state of Mexico and adjacent sites.

Sceloporus aeneus	
Cahuacán, Edo. de México	2750 m
Calimaya, Edo. de México	2690 m
G. Baz, Edo. de México	2270 m
Tenango del Valle, Edo. de México	2600 m
Transfiguración, Edo. de México	2800 m
Valle de Bravo, Edo. de México	1900 m
Villa del Carbón, Edo. de México	2600 m
Zempoala, Edo. de México	2900 m
Milpa Alta, D. F.	2700 m
El Capulin, D. F.	3000 m
Tres Cumbres, Mor.	2900 m
Sceloporus bicanthalis	
San Rafael, Edo. de México	3000 m
Paso de Cortés, Edo. de México	3599 m
Zoquiapan, Edo. de México - Puebla	3200 m
Sceloporus subniger	
Nevado de Toluca, Edo. de México	3500 - 4000 m

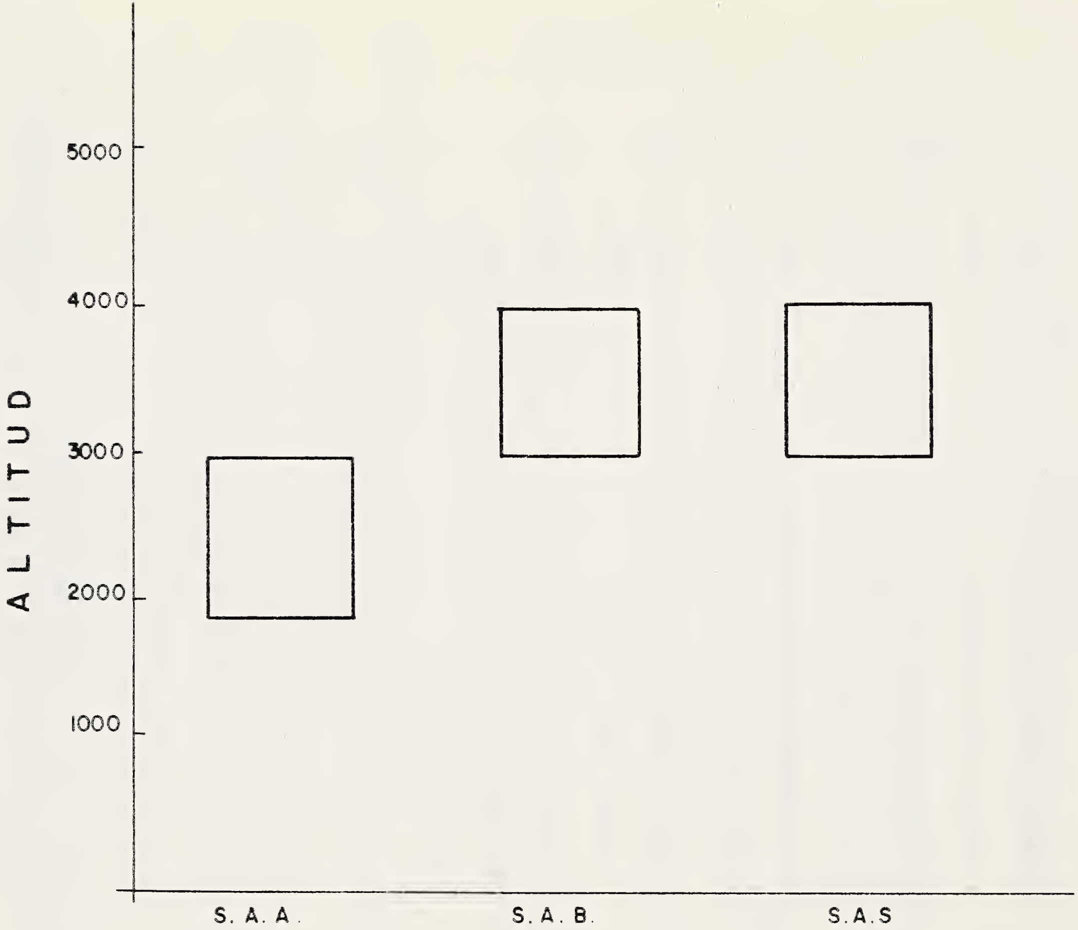


Fig. 1. Elevational distribution of the *Sceloporus aeneus* complex in the state of México.

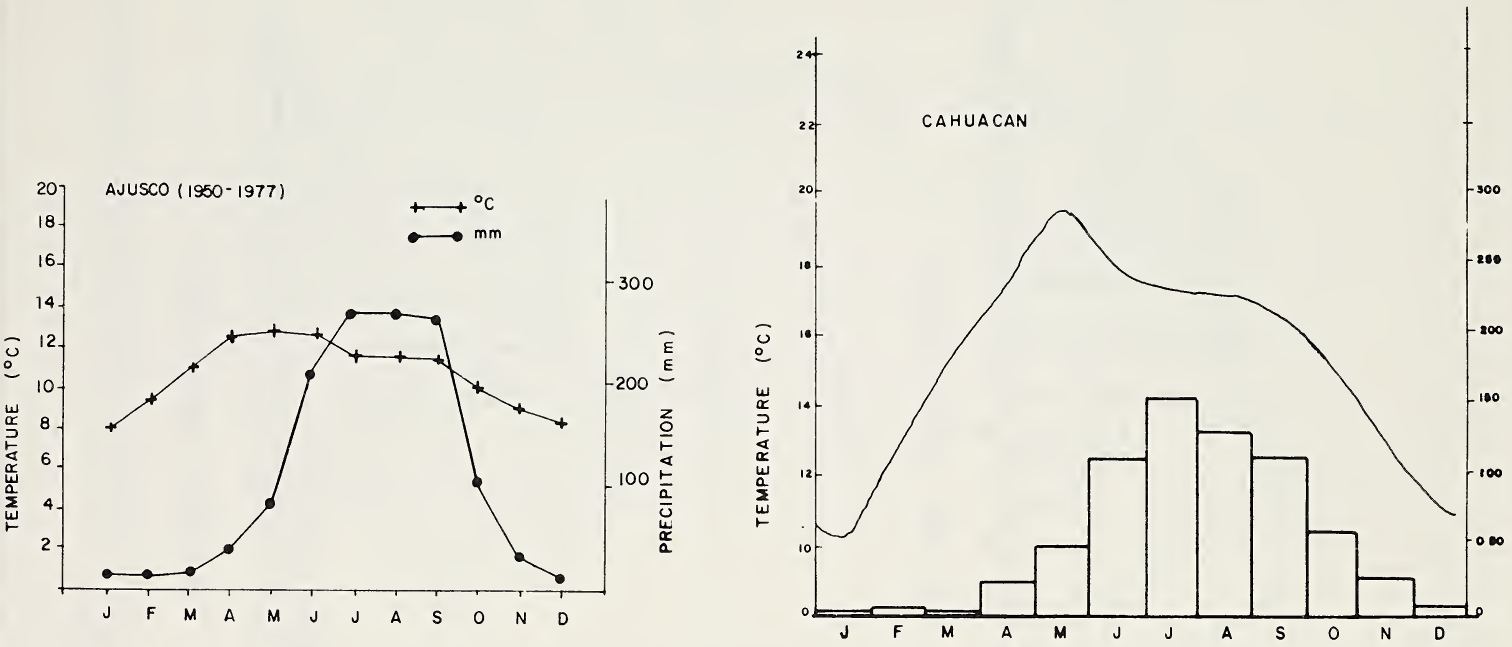
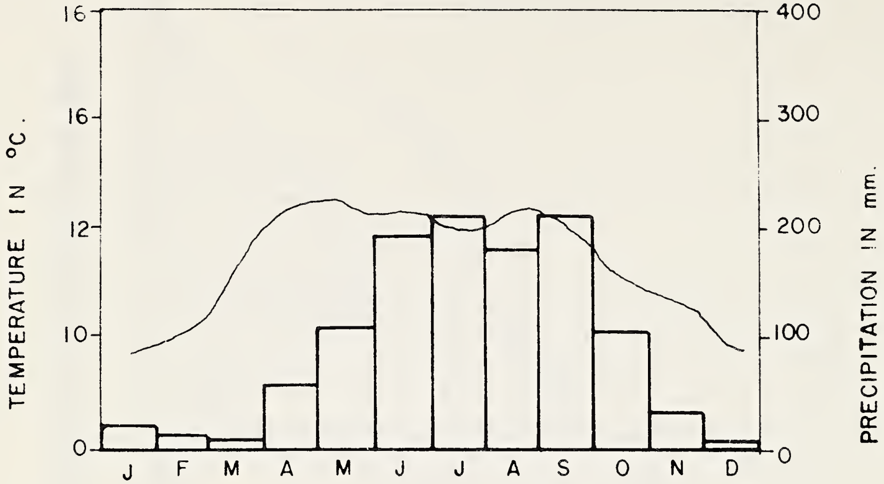
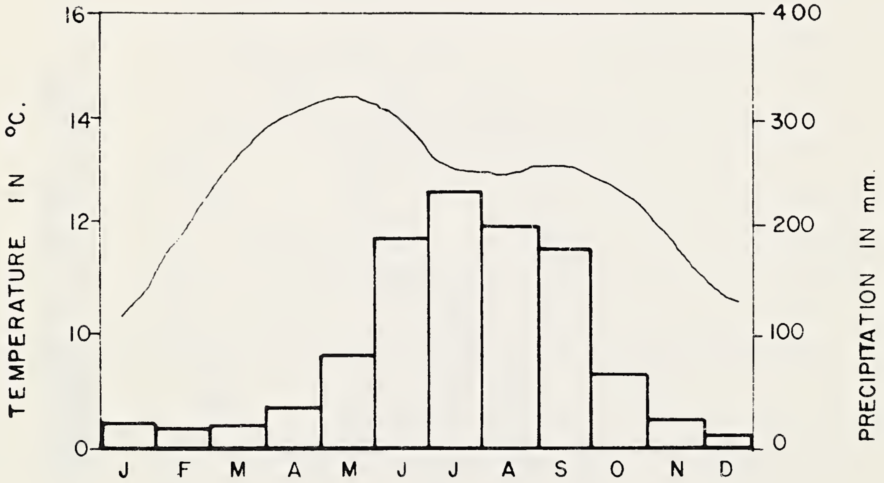


Fig. 2. Temperature and precipitation at two sites inhabited by *Sceloporus aeneus* (Guillette and Smith, 1985; Gutiérrez and Sánchez, 1986).



RIO FRIO, MEXICO, 3000 m



SAN RAFAEL, MEXICO, 2530 m

Fig. 3. Climatic parameters of habitat of *Sceloporus bicanthalis* (Maas et al., 1978).

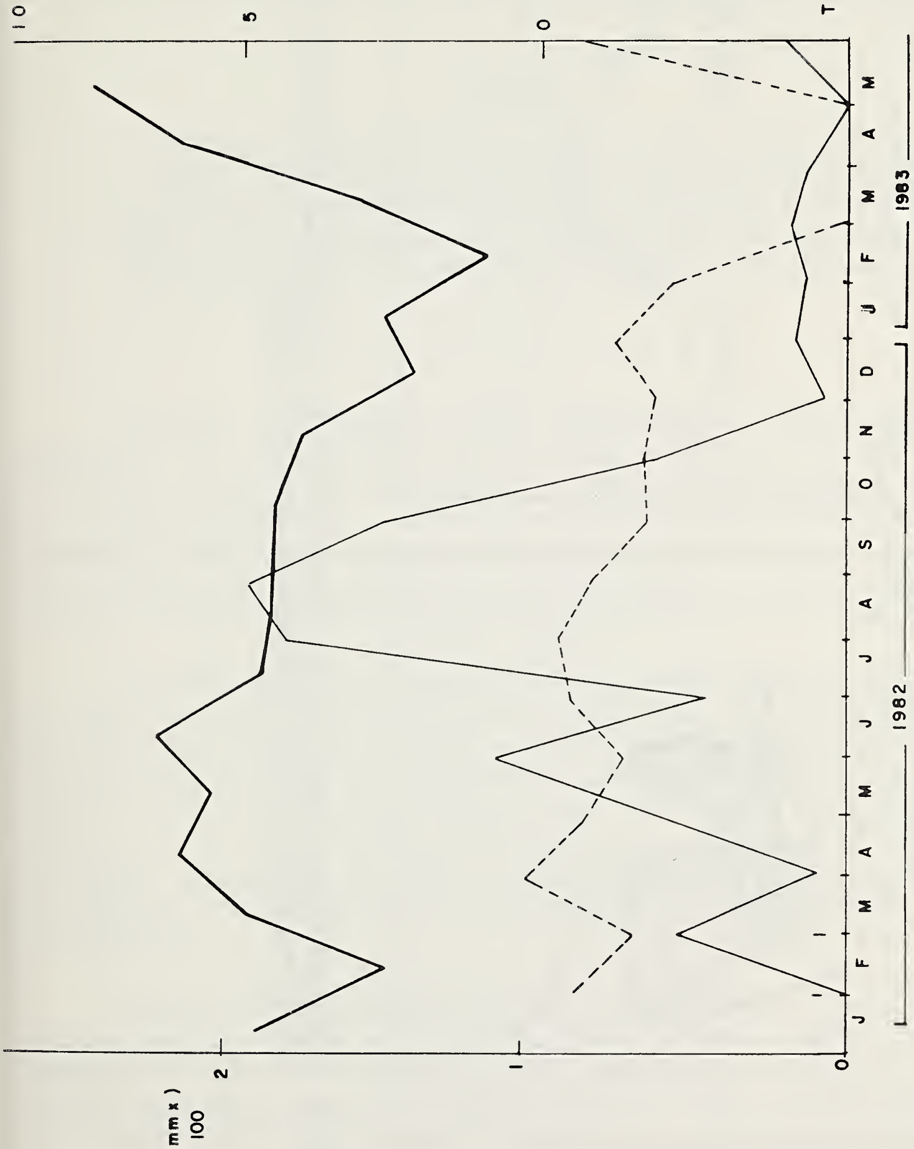


Fig. 4. Temperature and precipitation at the Volcano Nevado de Toluca, State of México (Banderas, 1984).

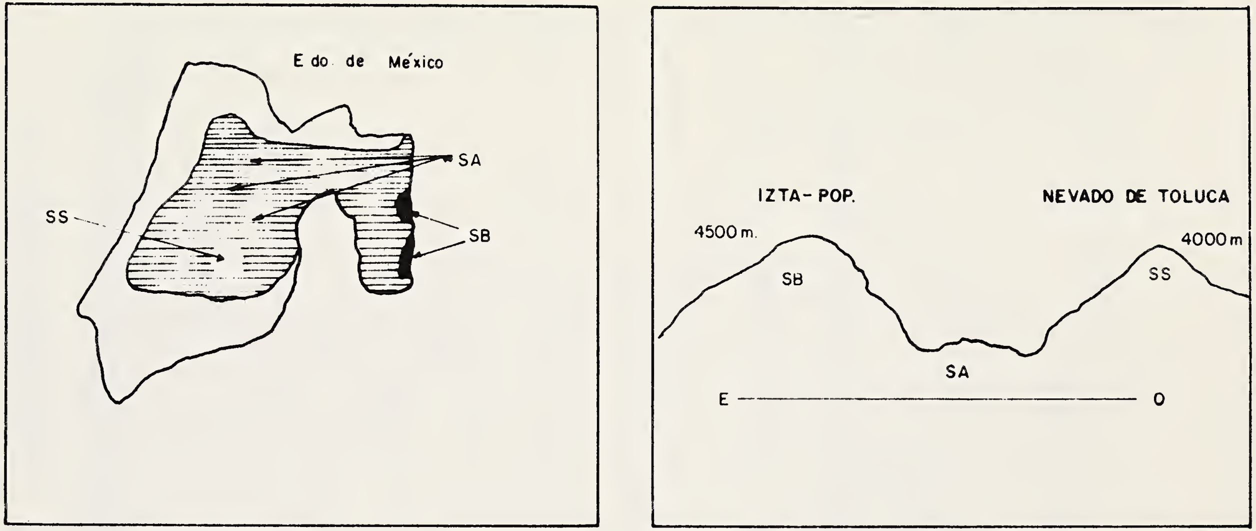


Fig. 5 Schematic representation of the geographic and elevational distribution of *Sceloporus aeneus* (SA), *S. bicanthalis* (SB), and *S. subniger* (SS) in the state of México.

THE NOMENCLATURAL STATUS OF *PELAMIS* DAUDIN, 1803 (REPTILIA: SERPENTES)

Hobart M. Smith, Kenneth L. Williams, Van Wallach and David Chiszar

Abstract

Although antedated by *Pelamis* Gouan, 1770, and by *Pelamis* Lacépède, 1802, *Pelamis* Daudin, 1803, a monotypic genus, long accepted for the yellow-bellied sea snake *P. platurus*, is not threatened nomenclaturally because Gouan's name is a nomen nudum, and Lacépède's name is a junior synonym rejected when published by its own author.

Williams and Wallach (1989: 110) noted that nomenclatural acceptability of the name *Pelamis* Daudin, 1803, is jeopardized by preoccupation of the name by *Pelamis* Lacépède, 1802, for fishes. In the interest of nomenclatural stability we have pursued the question to a definitive resolution within the dictates of the International Code of Zoological Nomenclature, without appeal to the International Commission of Zoological Nomenclature (ICZN) for exemption, and here present our conclusions.

Certainly the name *Pelamis* for the yellow-bellied sea snake should be maintained under any circumstance, for it has been used in that sense in hundreds of books and articles, almost without exception following Malcolm Smith's (1926) monograph of the sea snakes, and never as a valid name for any other group of animals. The sole species of the genus, *P. platurus*, is the most widely distributed of all sea snakes, occurring pelagically throughout the Indian and tropical/subtropical regions of the Pacific oceans, accounting thereby for its citation in so many works of such diverse focus.

Unfortunately the species has suffered from a great deal of nomenclatural confusion involving its generic name. Its specific name is secure, inasmuch as it stems (as *Anguis platura*) from Linnaeus (1766), although its objective synonym, *bicolor*, stemming from *Hydrus bicolor* Schneider (1799), was almost exclusively adopted throughout most of the 19th century.

Problems began with *Hydrus* Schneider (1799), in which nine species were recognized, including *H. bicolor*, an objective junior synonym of *A. platura* Linnaeus (1766) since Schneider included Linnaeus' species in his *H. bicolor*. Several genera, as now understood, were represented by those nine species, and much of the subsequent nomenclatural confusion revolved about the absence of any designation of type. That problem was resolved, however, by Opinion 18 of the International Commission on Zoological Nomenclature (1910: 43-44), designating *Hydrus caspius* as type species of *Hydrus* (and thereby making *Hydrus* Schneider, 1799, a jr. synonym of *Coronella* Laurenti, 1768, since *H. caspius* is a jr. synonym of *C. tessellata* Laurenti, 1768).

Actually, *Pelamis* was almost universally accepted, along with the improper specific name of *bicolor*, throughout most of the 19th century. The first to use the proper combination of *Pelamis platurus* was Stoliczka (1872: 92), but his precedent, except perhaps to call Boulenger's attention to the proper use of the specific name *platurus*, seemingly went unnoticed. Unfortunately, as Boulenger adopted the correct specific name, he came simultaneously to the conclusion (1890: 397) that the proper generic name to go along with the specific name was *Hydrus* Schneider. He continued to use that combination for over two decades, including his highly influential catalog (1896: 267) and his summary of the herpetofauna of the Malay Peninsula (1912: 180).

The confusion rapidly worsened after Boulenger's decisions of 1890 and 1896. Stejneger (1907: 438) agreed that the type of *Hydrus*, "as ascertained by the process of elimination," is *H. platurus*, which combination he accepted. Later (1910: 111), influenced by Opinion 18 of the ICZN published earlier that year, wherein the type species of *Hydrus* was fixed as *H. caspius*, he proposed the new name *Pelamydrus* for *A. platura*, arguing that *Pelamis* Daudin should be interpreted strictly as a substitute for *Hydrophis* Latreille (1801), having therefore the same type species as that genus, which Stejneger maintained should be interpreted in turn as a strict substitute for *Hydrus* Schneider (1799).

Malcolm Smith (1926: 41) pointed out that Latreille's name *Hydrophis* should not be interpreted simply as a substitute for *Hydrus*, in spite of Latreille's statement, because he reconstructed Schneider's species of *Hydrus*, making two genera (*Hydrophis* and *Enhydris)* out of them. His use of the word "substitute" was not in the current, strictly nomenclatural sense.

In like fashion, *Pelamis* Daudin should not be regarded as a strict substitute for *Hydrophis*, as pointed out by Smith and Taylor (1945: 177), regardless of any statement on his part, for he included one species Latreille did not include in his *Hydrophis*, and retained the genus *Hydrophis* but with a different composition from Latreille's. M. Smith (1926: 116) had come to the same conclusion, recognizing the validity of both *Hydrophis* and *Pelamis*, and all workers since then have followed his precedents with both genera.

The question raised by Williams and Wallach (1989: 110), however, concerns a still different threat to the security of *Pelamis* Daudin, 1803, namely that the name is preoccupied by *Pelamis* Lacépède, 1802. In fact, a still earlier *Pelamis* exists, of Gouan (1770: 42), applied to fishes; that usage is, however, a nomen nudum fide Neave (1940: 637), hence has no status nomenclaturally and does not threaten *Pelamis* Daudin.

In like fashion, *Pelamis* Lacépède, also applied to fishes, is nonexistent nomenclaturally, because the author himself rejected the name as a jr. synonym even as it was published: "Nomen ab ipso Auctore statim rejectum" (Schulze et al., 1935: 2557). That peculiar circumstance derives from the publication by Lacépède of a number of manuscript names provided by Plumier, as explained in Jordan (1963: 71): "Le Père Plumier, a missionary in Martinique, sent to Lacépède numerous paintings of fishes with descriptions and manuscript names. The generic names used...were polynomial and as they were not accepted by the author who published them in synonymy, we think they should not be considered eligible in scientific nomenclature...." On the next page, Jordan cited the type species given by Lacépède (for Plumier) "*Pelamis minima, vulgo sauteur* Plumier," and notes that the generic name, although nomenclaturally unavailable, applies to *Oligoplites* Gill, 1863.

Since *Pelamis* Lacépède has never been accepted in any published work, Art. 11(e) of the Code makes it clear that Lacépède's name is nonexistent nomenclaturally and therefore is no threat to *Pelamis* Daudin: "A name first published as a junior synonym is not thereby made available unless prior to 1961 it has been treated as an available name and either adopted as the name of a taxon or treated as a senior homonym...."

Since all obstacles to the security of *Pelamis* Daudin of which we are aware have been surmounted by the automatic provisions of the Code, we regard it unnecessary to appeal to the ICZN for official conservation of the name.

Acknowledgments

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SUPERCILIARY: PERTAINING TO THE EYEBROW OR ITS ANALOG

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Abstract

The term "superciliary" is overwhelmingly to be preferred over the term "supraciliary," on bases of both history and preponderance of usage, in reference to a region analogous to or equivalent of the mammalian eyebrow. The "ciliary" region, on the contrary, is the edge of the eyelids. "Supraciliary" structures are on the edge of the upper eyelid, "infraciliary" structures on the edge of the lower eyelid.

Since "supraocular" has long been the standard term for structures situated over the eye, as in reptiles and amphibians, the proper antithetical term for structures under the eye is "infraocular," not "subocular," because "sub" is antithetical to "super," not "supra." We hold that stability of terminology is, however, more important at this time than adherence to long-neglected rules, and recommend that usages of both "subocular" (rather than "infraocular,' antithetic to "supraocular") and "supraocular" (rather than "superocular," antithetic to "subocular") be maintained as in the past, for the alternatives have no history of use whatever in the English language.

Both of the terms "superciliary" and "supraciliary" occur in the English language and both have been used in the same sense occasionally in the distant past (as noted by the multivolume Oxford English Dictionary, hereinafter referred to by the acronym OED) as well as in more recent times. Particularly important is the detailed consideration of orbital scales by Thomas and Hedges (1989: 888), wherein "supraciliary" is adopted, whereas Smith (1946) adopted "superciliary" for all North American lizards, and Peters (1964: 344) also accepted that term in his herpetological dictionary.

We have attempted to determine which of these two terms is preferable, acknowledging that no bases exist in this context, nor in many other terminological ones, to rule categorically that one is correct, the other not. We can only argue preferability on grounds of appropriateness, original usage and custom.

Our conclusion is that both terms are acceptable, but of trenchantly different meanings. To begin with, the word "ciliary" has a firmly established, unequivocal meaning, referring to the edges of the upper and lower eyelids;

it also has special anatomical applications to structures within the eye, but these are of no pertinence to present concerns. The scales that line the edge of the upper eyelid are supraciliaries, and those that line the edge of the lower eyelid are infraciliaries; these meanings are clear-cut and not subject to deviation so far as we are aware, and conform with Peters (1964: 59). The terminology of Thomas and Hedges (1989: 890) is similar in restricting the term "ciliary" to the margins of the eyelids, but those on upper and lower eyelids are distinguished simply as "upper ciliaries" and "lower ciliaries" respectively. Other scales on the eyelids they term "palpebrals," although by lapsus the upper palpebrals in their figure are labelled "upper ciliaries."

However, acceptance of these terms with these meanings effectively excludes them for use in reference to other structures. Our present concern is with structures in a position comparable to that of the mammalian eyebrow. That area in most reptiles is the lateral edge of the supraocular disk, occupied in many lizards by distinctively-shaped scales. As early as 1732 the term "superciliary" was used for this region (OED) and it has since then acquired a strong preponderance of usage in that context, in herpetology (Peters, 1964: 344), ornithology (OED), mammalogy (OED) and anatomy (OED). Relatively few usages of the term "supraciliary" in the "eyebrow" context have occurred until recent years, fide Peters (1964) and the OED, all at least 100 years later than the first cited use of "superciliary" in that context. A major exception is Thomas and Hedges' (1989) terminological revision of orbital scales, in which "supraciliary" is adopted for the "eyebrow" scales, inasmuch as the ciliaries of the upper eyelid were simply termed "upper ciliaries." Peters' (1964) acceptance of "superciliary" in the "eyebrow" sense, however, was based on a massive precedent in herpetology, e.g. Cope (1900), Stejneger (1907), Van Denburgh (1922), Taylor (1936), Smith (1939) and many others.

Additionally, general knowledge even among moderately educated English-speakers of the cognate form, "supercilious," lends additional weight to preference for the term "superciliary." Recorded in English usage since 1529, "supercilious" is without doubt the best-known form of a number of related words. To insist on the term "supraciliary" in reference to reptilian scales would weaken the stability of the different but similar-sounding word "supercilious."

We accordingly conclude that the preferred term to be used in reference to structures in the region comparable to the mammalian eyebrow is "superciliary," and that the term "supraciliary" is most properly limited in application to the edge of the upper eyelid.

As is pointed out in the OED, the prefixes "supra" and "infra", and "super" and "sub," form strict correlatives, one being antithetical to the other. In that context, the term "subocular," commonly applied in herpetology to scales under the eye, would seem to be inappropriate, since the proper antithetical prefix to "supra" (in the context associated as "supraocular," a term now nearly universally accepted in herpetology for the area covering the eye) is "infra," hence "infraocular." If the term "subocular" were instead retained, the proper form for its antithetical term would be "superocular."

However, as indicated in the OED, custom, not rules, dictates proper usage. Never, in its records, have the terms "infraocular" or "superocular" been used, nor are they listed in Peters (1964). Accordingly usage of the virtually universally accepted terms "supraocular" and "subocular" should be maintained even though they are not antithetical mates.

In like fashion, "supraorbital" is a widely accepted word (OED; Peters, 1964), but "superorbital" has not been used (OED); "infraorbital" should be the preferred antithetical term, although "suborbital" has also been used, with no distinction in meaning.

Acknowledgments

We are much indebted to Dr. Richard R. Montanucci for calling our attention to the problem of consistency of terminology for the "eyebrow" scales of reptiles.

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NOTES ON REPRODUCTION AND COLORATION IN THE BUNCHGRASS LIZARD, *SCELOPORUS SCALARIS*, IN SOUTHEASTERN ARIZONA

Hobart M. Smith, Carl E. Bock and Jane H. Bock

Abstract

In the semidesert grassland of the Sonoita Plain in southeastern Arizona, no unicolor individuals were observed among about 100 *Sceloporus scalaris slevini* in the summer and fall of 1989. Reproduction occurs later on the Sonoita Plain than at higher altitudes in montane regions, and hatchlings are unusually large in proportion to adult sizes. A pair of postanal scales is much enlarged in males.

Observations on *Sceloporus scalaris slevini* Smith made 12-20 Aug. 1989 in the field in southeastern Arizona, and Sept.-Oct. later that year on, mostly, captive specimens, provide new information on coloration and reproduction, here summarized. Further background information, and an analysis of the effects of livestock grazing upon lizard abundance, is given in Bock, Smith and Bock (in press).

The study area is the 3160-ha (7830-acre) National Audubon Society Appleton-Whittell Research Ranch Sanctuary, and its vicinity, all on the Sonoita Plain, Santa Cruz Co., Arizona. This is a region of grassland and oak savannah between the Huachuca and Santa Rita mountains at an elevation of 1400-1560 m. A description of the area is given in Bock and Bock (1986), and its general history in Bahre (1977). Representative specimens are on deposit in the University of Colorado Museum.

The sexually dichromatic coloration of male *S. s. slevini* is as spectacular as any in the genus *Sceloporus*, with a bright, salmon streak 3-5 scales wide bordering dorsally a somewhat wider, bright pale blue streak on each side of the abdomen. VanDenburgh (1922) gave an excellent description of color in life of the subspecies, but emphasized that males may have a unicolor dorsal pattern instead of the usual striped/spotted pattern of females and some males.

From that account Stebbins (1966, 1985) inferred a general rule of sexual dichromatism. On the contrary, Anderson (1962) and VanDevender and Lowe (1977) noted that unicolor individuals occur in both sexes and constitute 14-20 per cent of the population; in their observations, 54-83 per cent of the unicolor individuals were females. Inexplicably, none of the 53 adult individuals we observed on the Sonoita Plain 12-20 Aug. were unicolor, and none were noted among the several dozen juveniles and adults flushed out 15-16 Sept. Presence of individuals with a unicolor dorsal pattern appears to be highly variable in this species, both interpopulationally and intersexually.

One hatchling *S. scalaris* caught 20 Aug. was 22.5 mm svl. Anderson (1962) stated that newly hatched young from 2600 m in Sierra del Nido, Chihuahua, measured x 20.6 mm svl (range 19.9 - 21.7); hence our hatchling was probably a few days old. Hatchling size is exceptionally large for lizards as small as *S. s. slevini*, approximately the same as for the considerably larger *S. undulatus consobrinus* Baird and Girard of the same area, one hatchling of which, 21 mm svl, was caught 6 Aug. at the Sanctuary.

All reproductive studies on this subspecies (Anderson, 1962; Newlin, 1976; Ballinger and Congdon, 1981) have been conducted on montane populations, and have recorded earlier oviposition than occurs at lower altitudes in the vicinity of Elgin. Previous reports note that eggs are laid as early as 8 July (Anderson, 1962) or "early to mid-July" (Ballinger and Congdon, 1981), and in the Chiricahua Mts. Newlin (1976) recorded that all lizards studied except one had oviposited by mid-August. On the contrary, at a devastated corral site 5 km west of Elgin several gravid females were observed 20 Aug., and one captured then and retained alive did not lay eggs until Sept. 8. Since a number of gravid females were observed at other localities but a few days earlier, it is apparent that oviposition occurs as late as late August or early September on the Sonoita Plain. When the ungrazed study areas were again visited briefly 15-16 Sept., more hatchlings than adults were observed, whereas none had been seen before 21 Aug. Disparity in onset of the rainy season between montane (earlier) and plains (later) areas may be more critical than temperature disparity in determining reproductive dates.

The female kept alive laid 6 eggs 3-4 mm deep in moist soil under a small, warmed board. The eggs all measured 7 mm width, the length varying from 9 to 11 mm. Four of the eggs apparently were infertile, and shrank completely; two enlarged to triple their original volume, measuring 13 x 11-12 mm on 29 Sept. They hatched on their 28th day, Oct. 5. The hatchlings resembled adults in their basic pattern, were extremely active, ate meal worms avidly, and both measured 20 mm svl, tail 23 mm. The postdepositional developmental period was longer than anticipated in view of the extended period of oviductal egg retention (as inferred from the late depositional date, and as generally assumed to be the case; Guillette, 1981); but perhaps conditions under which the female was kept, or incubation conditions, were suboptimal, although the eggs were kept in slightly moist soil under a thermal regime of 14 h at 28°C, 10 h at 21°C, surface temperatures, heat provided by an incandescent lamp. These temperatures are approximately those that obtained where and when the female was taken. The developmental period for these eggs, although longer than anticipated, was still less than half as long as in other, non-egg-retaining species of the genus (Fitch, 1970).

Ballinger and Congdon (1981) noted that at least in some years females outnumber males. Our observations support that conclusion; females were distinctly more abundant than males, although that difference is magnified by behavioral differences, females being less elusive, in part because of their bulk while gravid.

Although in some females one or even both of the paired postanal scales may be slightly enlarged, the enlargement is much greater in males, to approximately twice the width of any of the preanal scales, whereas in females the largest postanal is scarcely or no wider than the largest preanals. The statement in Ballinger and Congdon (1981) that "Both sexes have similarly enlarged post-anal scales" is incorrect.

Acknowledgments

Field work on this project was supported by the National Audubon Society, National Geographic Society, and National Science Foundation (Grant BSR 8703512) through Carl and Jane Bock. We are indebted to Eugene Knoder for field assistance and to Dr. Shi Kuei Wu for curating collected material.

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NOMENCLATURAL PRIORITY OF *GEOPHIS* WAGLER, 1830, OVER THE SIMULTANEOUSLY PUBLISHED SYNONYM *CATOSTOMA* WAGLER, 1830 (REPTILIA: SERPENTES)

Hobart M. Smith, Kenneth L. Williams, Van Wallach and David Chiszar

Abstract

Although *Geophis* was published on a page near the end of Wagler's Natürliches System der Amphibien (1830), as a substitute for *Catostoma* of a preceding page, the two names actually were published simultaneously in the same work. Therefore the first-reviser rule (Art. 24) is in effect to establish relative priority. The first reviser, in the present case, who conforms with the requirements of the Code is Bocourt (1883), who chose *Geophis*. Therefore *Catostoma* is an invalid, objective junior synonym of *Geophis*, the valid name for its genus under the Code, requiring no action by the Commission.

The nominal snake genus *Geophis* Wagler, 1830, has been universally accepted as valid since Amaral (1930a: 94; 1930b: 190), who adopted the name *Catostoma* Wagler, 1830. Between 1859 and the present time, hundreds of works and authors have utilized the name *Geophis* in lieu of *Catostoma*, both of which have the same type species, *Catostoma chalybeum* Wagler, 1830, and a highly influential monograph of the genus under the name of *Geophis* has been published (Downs, 1967). In the interest of nomenclatural stability, a primary object of the International Code of Zoological Nomenclature, use of the generic name *Geophis* should be assured in perpetuity.

The name *Geophis* was proposed as a substitute (Wagler, 1830: 342) for the new name *Catostoma* of an earlier page in the same work (Wagler, 1830: 194), hence having the same type species (*C. chalybeum* Wagler, 1830: 194. Wagler had erroneously assumed that *Catostoma* was preoccupied by *Catostomus* Lesueur, 1817 (Pisces). Art. 24 of the Code rules that the first reviser's selection between any two or more names simultaneously published determines their relative precedence.

The substitution by Wagler of one name, proposed late in the work, for another name, proposed earlier in the same work, poses a question whether that work may actually have been published in parts. If so, the Code dictates that, under its automatic provisions (the Principle of Priority, Art.

23), the first published name (*Catostoma*) would be valid. On the contrary, if the whole work was published as a single unit, selection of the first reviser (Art. 24) would determine the relative precedence of the two names.

We consulted Dr. Kraig Adler, foremost herpetological historian, for information on the mode of publication of Wagler's (1830) work, and because of the importance of this consideration, we quote his reply in its entirety:

"In response to your inquiry concerning publication of Wagler's 1830 book, I can find no evidence that it was published in parts. There is no such indication in my copy nor in Cornell's, and none of the standard bibliographic references even hints at it. Even William Wood's book catalogue of 1832, which was probably the most comprehensive listing of natural history in its day and issued just after publication of Wagler's book, simply says "1830, Pages 354. Plates (folding) 2."

As you note, on p. 342 Wagler cites by exact page number two genera cited earlier in the book on pp. 172 and 181. Thus, he must have had paged proofs at the time he wrote this part of the "Zusätze." I surmise that this was added just before publication and even after the errata pages (pp. 353-354). You'll note that the errata covers through page 294 only; it is hard to believe that there were no errata at all in the last sixth of the book, when there were so many in the first five sixths.

As further evidence that this part of the "Zusätze" was added last, you'll note that all three genera of "Amphibien" newly named in this section are not in the index. This implies that even the index was set in type by that time and, therefore, the printer allowed Wagler to add his addenda on pp. 341-342 but not to reset the index to accommodate these new names. It is not unusual even today for a printer to allow this sort of addenda, with the same restrictions.

I think it is safe to conclude that Wagler's book was issued as a single entity (plus the separate folio atlas of plates), and thus the first revisor rule would apply to the names Catostoma and Geophis."

We agree with Dr. Adler's authoritative conclusion, and regard it justified to conclude definitively that Wagler's (1830) work was published as a single unit.

The next step is to determine which work qualifies as a "first reviser" action. In this context we have benefitted from the authoritative counsel, to which we adhere, of Dr. Philip K. Tubbs, Secretary of the International Commission on Zoological Nomenclature.

The earliest possible candidate as first reviser is Wagler (1830) himself, since his ultimate act in that work was selection *Geophis*. That was the conclusion of Smith and Taylor (1945: 64-65). Although the 1961 and 1964 editions of the Code might be interpreted as permitting that conclusion, the 1985 edition definitely does not, making clear that only the author of a *subsequent* work can be considered as the first reviser.

The next author to deal with either generic name is Fitzinger (1843: 25), who chose *Geophis* without mentioning *Catostoma*. That action does not qualify Fitzinger (1843) as the first revisor since the Code (1961, 1964, 1985 editions) requires that all of the competing names be cited as a selection is made among them. The same conclusion pertains to the next usage (Peters, 1859: 275) for the genus; the name *Geophis* was adopted, but *Catostoma* was not mentioned.

Cope (1860: 339) was the first author to cite both names and to choose between them. He chose *Catostoma* in the mistaken belief that *Geophis* was attributable to Fitzinger (1843), even though the latter author attributed the name to Wagler (1830), hence *Catostoma* Wagler was accepted under the impression of its priority. Cope (1860) cannot be accepted as first reviser because he did not choose between *Geophis* Wagler (1830) and *Catostoma* Wagler (1830).

The next work properly citing both names and choosing between them is Bocourt (1883: 528), who selected *Geophis*. Bocourt qualifies as of that work as the first reviser, and accordingly the valid name for the genus to which both names were applied is *Geophis* Wagler, 1830, under the automatic provisions of the Code. No appeal to the Commission for name conservation is therefore necessary.

Acknowledgments

We are much indebted to both Drs. Kraig Adler and Philip K. Tubbs for vital counsel.

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AN AMELANISTIC PARTIAL ALBINO *CROTALUS HORRIDUS* (TIMBER RATTLESNAKE) FROM SOUTH CAROLINA

On 20 July 1989 an amelanistic partial albino *Crotalus horridus* was collected in Horry County, South Carolina by a local individual. The specimen, a male, was ca. 1350 cm. total length when captured and exhibits similar color and pattern characteristics as an individual collected in Red River County, Texas and described by Hudson (Herp Review 16(1), 1985). This specimen lacks the pink iris and red pupil color of the Red River County specimen, instead possessing yellow irises and black pupils.

This individual represents the second such specimen collected in Horry County, South Carolina. In 1972, a juvenile amelanistic *C. horridus* was captured and subsequently preserved in the collection of a Horry County High School. Both specimens are now in the possession of the Riverbanks Zoological Park. The animal collected 20 July 1989 will be maintained in the reptile collection at the RZP. Upon death, this specimen will be deposited in the Vertebrate Collection of the South Carolina State Museum. The preserved juvenile will also be place in the Vertebrate Collection of the South Carolina State Museum.

—CHARLES F. SMITH and SCOTT PFAFF, Department of Herpetology, Riverbanks Zoological Park, 500 Wildlife Parkway, Columbia, South Carolina 29210.

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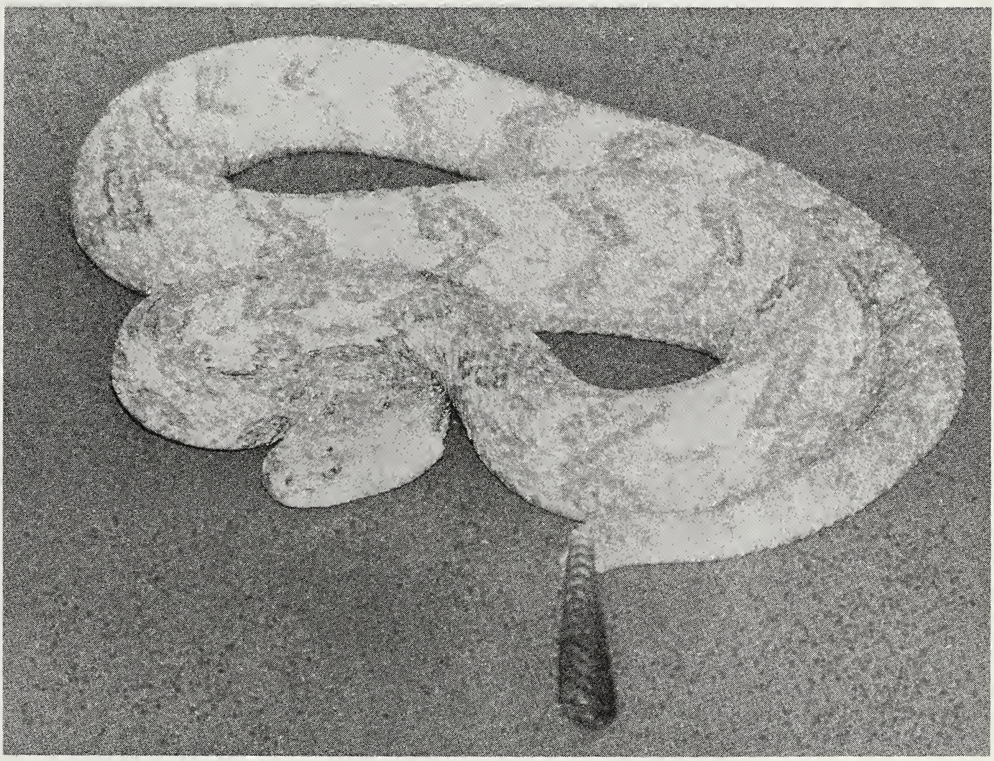

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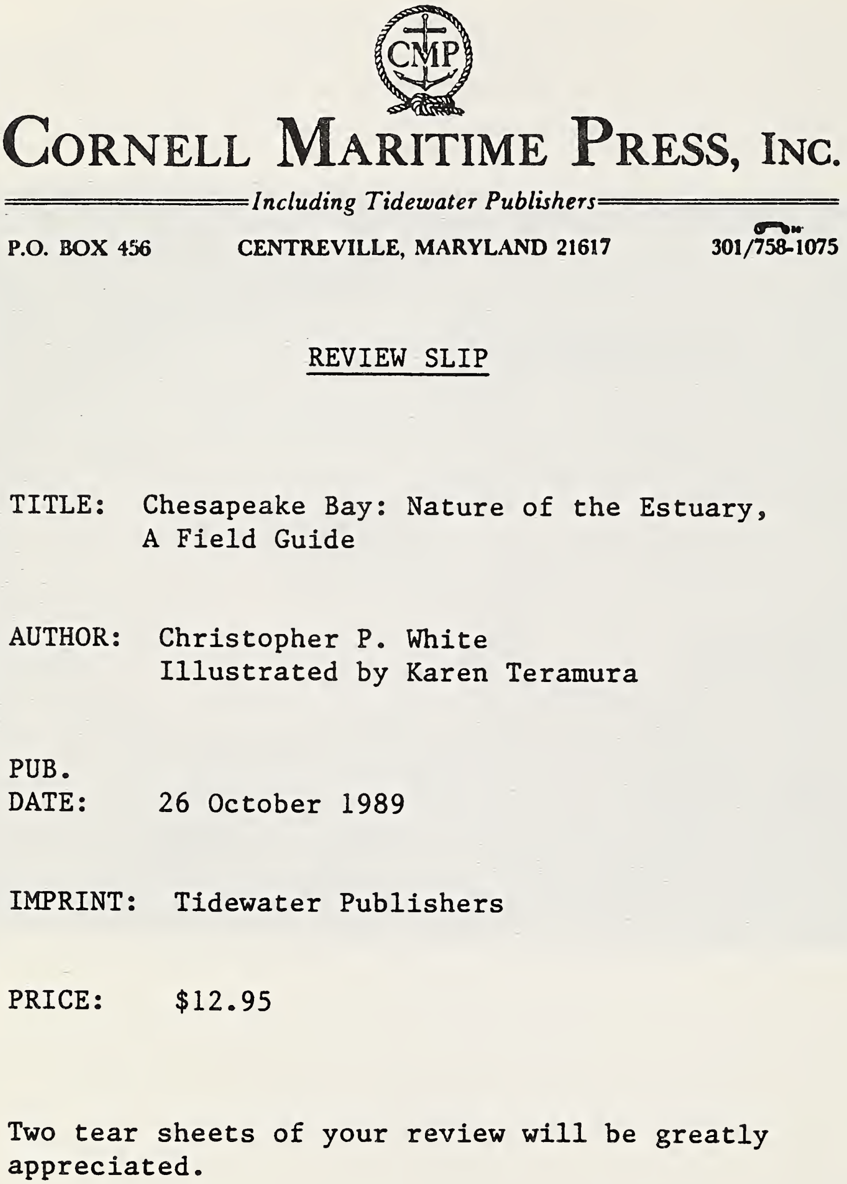

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•Turtles of Quintana Roo, Mexico
Dr. Hans Herrmann (Scripps Institution of Oceanography) and staff will patrol the Yucatan's sea turtle nesting beaches to protect them from poachers and to study their reproductive success, population dynamics, and habitats. *Ten day teams leave 6/14, 6/26, 7/8, 7/19, and 7/31.*

•Diamondback Terrapins
Dr. J. Whitfield Gibbons (U. of Georgia) and his colleagues will define the population structure and feeding behavior of Terrapins on Kiawah Island, South Carolina. Data will aid in species management and habitat protection. *Teams leave 5/16, 6/27, 7/7, and 8/15.*

•South China Sea Islands
Dr. James Lazell (The Conservation Agency) will be surveying the reptiles and the mammals of the Hong Kong islands to construct a biogeographical model for future environmental management policies. *Teams leave 5/14, 6/3, 6/17, 7/1, 7/22, and 8/5.*

•Island Rain Forest in Brazil
Dr. Tim Moulton (CEPARNIC) and Dr. Bill Magnusson (Instituto Nacional de Pesquisas de Amazonia) are surveying the reptiles and amphibians of Ilha do Cardosa; describing and tagging animals; and recording nest size of the broad-nosed caiman, a small crocodile. *Teams leave 1/13 and 7/14.*

Ecology

•Australia's Shrinking Wildlands
Dr. Denis Saunders (CSIRO) will census and capture echidnas, kangaroos, and some of 80 species of birds which use the native strips of vegetation in western Australia left standing between wheatbelts to determine how healthy the vegetation is and how animals are adapting. *Teams leave 8/12 and 10/14.*

•Conservation in Tibet
Dr. Kurt Johnson (World Wildlife Fund) will develop a management plan for a wildlife sanctuary in the high plateau of Tibet. *Teams leave 7/14 and 8/6.*

•Tibetan Plateau
Dr Stephen Dobson (Auburn U.) will investigate the pika (relative of the rabbit), its family life, and how habitat influences social organization and behavior near the quaint village of Shenduo. *Teams leave 4/8, 4/29, 5/20, 6/10, 7/1, 7/22, and 8/12.*

•Alpine Meadows
At Rocky Mountain Biological Laboratory in Gothic, Colorado, Dr. Michael Soule (U. of California, Santa Cruz) continues his study of the effects of climate change, acid rain, mining, grazing, and recreation on meadow ecosystems. *Teams leave 6/10, 6/24, 7/15, 7/29, and 8/12.*

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Amid Peru's virgin tropical rain forest, Dr. David Nickle (Smithsonian Institution) will conduct day and night shifts in search of katydids - a vital link in the rain forest ecosystem. *Teams leave 7/7, 7/21, and 1/13.*

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At Los Tuxtlas Biological Reserve in Veracruz, Dr. Alejandro Estrada (U. Nacional Autonoma de Mexico) will census wildlife in the continent's last remaining rain forest fragments to recommend future management programs. *Teams leave 7/1, 8/1, 12/1, 1/5/91, 1/25, and 2/15.*

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(2) A list of all species bred during the previous year. Information may be sparse with simply an indication that the taxon was bred during the year, or it may be quite lengthy including, but not limited to: dates of copulation, dates of egg laying and hatching, types of substrates and temperature used during incubation, light cycles, hibernation, etc. Any type of valuable information up to three or four paragraphs may be used.

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Volume 26 Number 3 September 1990

COMPARATIVE ESCAPE BEHAVIOR OF ADULT GREEN FROGS (*Rana clamitans*) AND NORTHERN LEOPARD FROGS (*R. PIPIENS*)

Floyd E. Hayes

Abstract

I studied and compared the escape behavior of adult green frogs (*Rana clamitans*) and northern leopard frogs (*R. pipiens*) in Michigan, USA. When approached by a potential predator, *R. pipiens*, which frequented land more than *R. clamitans*, was more likely to escape toward land, especially when approached from water. *R. clamitans* preferred to jump into the water regardless of the manner approached. *R. clamitans* was more likely to dive than *R. pipiens* when approached by land; *R. pipiens* was more likely to dive when approached from water or pursued. Because both species were more likely to escape toward water and dive when pursued than when casually approached, jumping and swimming appeared to be the preferred methods of escape; frogs dived only when necessary. The species-specific escape responses of frogs varied according to the approach of the predator, independent of the habitat (land or water) occupied by the frogs prior to approach. Interspecific differences in habitat preferences were not accompanied by appreciable differences in body size, relative hind limb length or jumping ability. Morphological similarity may have accounted for similarities in jumping and diving ability. The more disruptive coloration and less extensive webbing on the hind feet of *R. pipiens* were consistent with its more terrestrial habits.

Key Words: Anura, Ranidae, *Rana clamitans*, *Rana pipiens*, Escape behavior, Defensive behavior, Habitat preference, External morphology.

The tactics employed by a given organism in order to avoid predation are limited by the environment in which it lives and by morphological constraints (Edmunds, 1974). In adult frogs, cryptic coloration, color changes, immobility, crouching and hiding serve as primary defenses (Edmunds, 1974), which help prevent detection by potential predators (Bragg, 1945; Marchisin and Anderson, 1978; Wendelken, 1978; Gregory, 1979; Tordoff, 1980; Kats and Van Dragt, 1986; Licht, 1986). Secondary defenses (Edmunds, 1974), which facilitate escape during predator attack, include jumping, swimming, diving, flashing bright colors or eye spots on thighs, walking, climbing, chin tucking, biting, mouth gaping or displaying bright tongue, defensive posturing, noxious or toxic secretions, mimicry of toxic species, inflation, holding onto the substrate, kicking, death feigning and vocalization (Bragg, 1945; Bogart, 1960; Myers, 1966; Daly and Myers, 1967; Davies, 1968; Villa, 1969; Nelson and Miller, 1971; Hedeen, 1972; Altig, 1974; Sazima, 1974, 1975; Veloso, 1977; Daly et al., 1978; Marchisin and Anderson, 1978; Cei, 1980; Myers and Daly, 1983; Duellman and Trueb, 1986).

Species-specific differences in the escape patterns exhibited by adult frogs are often related to habitat preferences and external morphology (Rand, 1952; Heatwole, 1961; Gans and Parsons, 1966; Gans and Rosenberg, 1966; Hedeen, 1972; Gregory, 1979; Licht, 1986). When approached by a predator, frogs usually remain immobile, relying on their cryptic coloration to avoid detection, until the predator approaches too closely (Marchisin and Anderson, 1978; Wendelken, 1978; Gregory, 1979; Licht, 1986). The approach distances of frogs, defined as the distance between the predator and a frog when flight takes place (Hediger, 1968:40-41), are greater for larger predators than for smaller predators (Gregory, 1979; Hayes, unpublished data). Relatively little is known about the effects of predator approach variability on the escape behavior of frogs.

This study examines and compares the methods of escape employed by adult green frogs (*Rana clamitans*) and northern leopard frogs (*R. pipiens*) when subjected to different methods of approach by a potential predator. The extent to which habitat preferences and external morphology may relate to escape behavior of the two species is also considered.

Methods

The study area was situated along the shores of Van Pond, a ca. 3 acre, ecologically disturbed pond approximately 4 km north of Pellston, Emmet County, Michigan. All observations were made during July and August 1986.

Habitat and Orientation

To determine the habitat preferences and orientation with respect to the shoreline of each frog species, I walked slowly along the shoreline of the pond and recorded whether undisturbed frogs within 1.0 m of the shoreline were in the water or on land, and whether undisturbed frogs were facing toward water or land. Data for frogs that were partially on both land and water or that were parallel to the shoreline were rejected. Chi-square tests (X^2-statistic; Siegel, 1956) were used to determine whether the species differed in their habitat preferences and orientation.

Escape Behavior

I approached frogs by three different methods to determine whether frogs responded selectively to different types of predator approaches: (1) walking casually from land; (2) walking casually from water; and (3) walking along the shoreline and actively pursuing frogs by attempting to touch them with an extended foot. For each frog approached, I recorded the habitat (land or water) the frog initially inhabited, and whether the frog jumped onto land or into water. For frogs that jumped first onto land and then into water or vice versa, I recorded the final choice made. I also recorded whether the frogs that jumped into the water swam or dived. Dives were timed with a stopwatch, and the direction faced (toward water or land) by the frogs after surfacing was recorded. The orientation (toward or away) of frogs with respect to the predator (i.e., the investigator) was recorded when flight ceased for frogs that swam or jumped away. For captured frogs, I recorded whether or not distress calls were given, and subjectively compared the ease with which the frogs could be captured.

The escape preference data were organized into two separate 2 (SPECIES of frog: *R. clamitans* or *R. pipiens*) X 3 (APPROACH by predator: land, water or pursue) X 2 (HABITAT of frog: land or water) X 2 (RESPONSE of frog: jump onto land or into water in the first table, and swim or dive in the second table for frogs that jumped into the water) contingency tables for subsequent analyses. Hierarchical log-linear models were then fitted to the logarithmic transformations of the expected frequencies for each category, and the likelihood-ratio chi-square statistic (X_L^2) was used to evaluate the relationships between variables (Everitt, 1977). Mann-Whitney *U* tests (*U*-statistic; Siegel, 1956) were used to compare the duration of dives for each species. Chi-square tests were used to determine whether the species differed in their orientation behavior and in the frequency of distress calls emitted.

External Morphology and Jumping Ability

Individuals of both species were captured and measured to examine morphological relationships between snout-vent length (SVL), hind limb length (HLL) and degree of webbing (DW) on the hindfoot. I measured (nearest mm) the length between the snout and vent (SVL) of each frog, the length of the outstretched right hind limb from vent to tip of fourth (longest) toe (HLL), and distances (summed in the subsequent analysis) between the tip of the fourth toe and the webbing on both sides of the toe (DW). I also subjectively compared the coloration of the two species.

To compare relationships between external morphology and jumping ability, I placed each frog on the ground in a flat muddy area, and measured (nearest cm) the longest of the first three jumps; the jumps were initiated by slapping the ground beside the frog.

After plotting the data for both species on graphs comparing SVL as a function of (a) HLL and (b) DW, and the distance jumped as a function of (a) SVL and (b) HLL, I compared the slopes and y-intercepts of the regression lines for each species in each graph using the F-statistic (Sokal and Rohlf, 1981) and t-statistic (Zar, 1984), respectively, to determine whether the species differed in external morphology and jumping ability.

All statistical tests were performed using *Statistix* software (Heisey and Nimis, 1985), except for the comparison of regression lines, which was done with *Ministat* software (Bonnet, 1987). The level of significance in all tests is alpha = 0.05. All probabilities of normal-approximated distributions are two-tailed.

Results

Habitat and Orientation

Although both species of frogs preferred to be on land, *R. clamitans* occurred in the water more often than *R. pipiens* (Table 1). *R. pipiens* frequently wandered 10+ m from the pond. In contrast, *R. clamitans* seldom strayed far from water; only two individuals were observed further than 1 m from the shoreline, and none more than 2 m.

While resting near shore, *R. pipiens* faced the water more frequently than land ($X^2 = 5.52$, df = 1, $P < 0.025$) and *R. clamitans* oriented randomly with respect to the shoreline ($X^2 = 1.71$, df = 1, $P > 0.10$); however, the two species did not differ significantly (Table 1).

Table 1. Habitat preference and orientation with respect to the shore line of *Rana clamitans* and *R. pipiens*.

	Habitat Preference[1]			Orientation[2]		
Species	N	Land (%)	Water (%)	N	Land (%)	Water (%)
R. clamitans	220	69.5	30.5	84	42.9	57.1
R. pipiens	330	85.8	14.2	87	32.2	67.8

[1] $X^2 = 20.14$, df = 1, $P < 0.001$

[2] $X^2 = 1.65$, df = 1, $P > 0.10$

Escape Behavior

The frequency of frogs jumping toward land or water when approached by three different methods and the frequency of frogs swimming or diving after jumping into water are given in Table 2. I began my log-linear analyses of these contingency tables by first computing the X_L^2 values and degrees of freedom (df) for the saturated model, which included all parameters and therefore provided an adequate fit to the data, and then compared this model with simpler hierarchical models including fewer parameters. In both log-linear analyses, the main effects model (model #1 in both analyses; see Table 3), which tested the hypothesis that all variables were independent, and the model including all first-order interaction terms (model #2 in both analyses) differed significantly ($P < 0.05$) from the saturated model, indicating that the model which best fit the data included at least one second-order interaction term (Table 3). I then calculated the X_L^2 and df values for each possible model including one or more second-order interaction terms, and compared these with the saturated model. The model chosen that best fit the data was that which did not differ significantly from the saturated model ($P > 0.05$) and had the fewest parameters, unless a rival model with more parameters provided a significantly improved fit over the simpler model as evaluated by the differences in the X_L^2 and df values.

Table 2. Frequency of *Rana clamitans* and *R. pipiens* responding by jumping toward land (L) or into water (W) when approached by three different methods (Response A), and frequency of frogs swimming (S) or diving (D) after jumping into water (Response B). Habitat refers to the substrate occupied by frogs prior to the escape response.

APPROACH	Land				Water				Pursue			
HABITAT	Land		Water		Land		Water		Land		Water	
RESPONSE A	L	W	L	W	L	W	L	W	L	W	L	W
R. clamitans	4	100	1	23	2	25	5	32	1	28	4	39
R. pipiens	42	160	2	25	46	40	11	18	10	101	7	40
RESPONSE B	S	D	S	D	S	D	S	D	S	D	S	D
R. clamitans	74	26	12	11	18	7	21	11	8	20	10	29
R. pipiens	143	17	17	8	7	33	6	12	6	95	2	38

Table 3. Log-linear analyses of variables associated with escape responses by *Rana clamitans* and *R. pipiens*. S = species; A = approach; H = habitat; and R = response (see text for explanation).

Model Number and Design	df	X_L^2	*P*
Jump Toward Land or Water			
1. S+A+H+R	18	206.66	0.001
2. S+A+H+R + SA+SH+SR+AH+AR+HR	9	17.04	0.048
3. S+A+H+R + SA+SH+SR+AH+AR+HR + SAH	11	107.20	0.001
4. S+A+H+R + SA+SH+SR+AH+AR+HR + SAR	11	105.98	0.001
5. S+A+H+R + SA+SH+SR+AH+AR+HR + SAH+SAR	6	8.20	0.224
6. S+A+H+R + SA+SH+SR+AH+AR+HR + SAH+SAR+SHR	4	5.18	0.269
7. S+A+H+R + SA+SH+SR+AH+AR+HR + SAH+SAR+SHR+AHR	2	0.28	0.871
Swim or Dive			
1. S+A+H+R	18	402.09	0.001
2. S+A+H+R + SA+SH+SR+AH+AR+HR	9	66.39	0.001
3. S+A+H+R + SA+SH+SR+AH+AR+HR + SAH	11	318.00	0.001
4. S+A+H+R + SA+SH+SR+AH+AR+HR + SAH+SAR	6	12.92	0.044
5. S+A+H+R + SA+SH+SR+AH+AR+HR + SAH+SAR+SHR	4	8.67	0.070
6. S+A+H+R + SA+SH+SR+AH+AR+HR + SAH+SAR+AHR	3	2.12	0.548
7. S+A+H+R + SA+SH+SR+AH+AR+HR + SAH+SAR+SHR+AHR	2	2.03	0.362

The significance of each first-order interaction term, calculated as the difference in df and X_L^2 between the main effects model and the independent addition of each first-order interaction term, is given in Table 4 for both analyses. For frogs that jumped onto land or into water following the approach of a predator (Response A in Table 2), the model that best fit the data (model #5) included two second-order interaction terms: species x approach x habitat and species x approach x response (Table 3). The first of the significant interaction terms (species x approach x habitat) reflected variation in data sampling and sample sizes: both species of frogs were encountered less frequently in water when approached from land, especially *R. pipiens*. The second interaction term (species x approach x response) indicated that the two species of frogs differed in their escape behavior. Both species of frogs jumped toward land more frequently when approached from water than when approached from land or pursued, and when pursued both species preferred to jump toward water. *R. pipiens* was more likely to jump toward land than *R. clamitans*, especially when approached from water; *R. clamitans* always preferred to jump toward water regardless of how a predator approached. The absence of a significant interaction between habitat and response (Table 3 and 4) indicated that the escape responses of the frogs toward land or water varied according to the approach of a predator, independent of the habitat occupied by the frogs prior to approach.

Table 4. Significance of independent first-order interactions for variables associated with escape responses by *Rana clamitans* and *R. pipiens*.

Interaction	df	X_L^2	*P*
Jump Toward Land or Water			
Species X Approach	2	1.46	> 0.40
Species X Habitat	1	30.37	< 0.001
Species X Response	1	39.73	< 0.001
Approach X Habitat	2	57.53	< 0.001
Approach X Response	2	49.29	< 0.001
Habitat X Response	1	1.98	> 0.10
Swim or Dive			
Species X Approach	2	9.50	< 0.01
Species X Habitat	1	19.84	< 0.001
Species X Response	1	6.99	< 0.01
Approach X Habitat	2	48.68	< 0.001
Approach X Response	2	249.83	< 0.001
Habitat X Response	1	16.55	< 0.001

For frogs that swam or dived after jumping into the water following the approach of a predator (Response B in Table 2), the model that best fit the data (model #6) included three second-order interaction terms: species x approach x habitat, species x approach x response, and approach x habitat x response (Table 3). As with Response A, the first significant interaction (species x approach x habitat) reflected variation in data sampling and sample sizes. The second interaction (species x approach x response) indicated that, after jumping into water, *R. clamitans* was more likely to dive than *R. pipiens* when approached by land, and *R. pipiens* was more likely to dive when approached from water or when pursued. Both species were more likely to dive when pursued than when casually approached. The third interaction term (approach x habitat x response) indicated that frogs were less likely to dive when approached from land, especially those on land prior to approach.

The lack of a significant interaction between species, habitat and response for both responses (Table 3) indicated that the species-specific responses of frogs to the approach of a predator were independent of the habitat occupied by the frogs prior to approach.

Although both species of frogs preferred to face away from the predator after flight ceased, *R. pipiens* was more likely to (Table 5). In contrast with *R. pipiens*, which almost always fled directly away from the predator, *R. clamitans* often swam back to shore and faced the predator.

Table 5. Orientation of *Rana clamitans* and *R. pipiens* with respect to predator when flight ceased.

Species[1]	N	Toward (%)	Away (%)	X^2	P
R. clamitans	56	30.4	69.6	8.64	< 0.001
R. pipiens	66	7.6	92.4	47.50	< 0.001

[1] $X^2 = 9.15$, df = 1, $P < 0.001$

The duration of dives did not differ significantly between the species (Table 6). Both species of frogs oriented and swam toward land 90% of the time (N = 20 for both species) when surfacing from a dive.

Table 6. Duration (sec) of dives in *Rana clamitans* and *R. pipiens*

Species[1]	N	Mean	Min	Max	SD
R. clamitans	20	176.4	25	768	201.8
R. pipiens	25	96.6	23	211	43.4

[1] $U = 298$, $P > 0.20$

When captured, 13.3% of *R. clamitans* (N = 15) and 16.0% of *R. pipiens* (N = 25) emitted distress calls; the frequency of distress calls did not differ between the species ($X^2 = 0.05$, df = 1, $P > 0.80$). *R. clamitans* appeared easier to catch than *R. pipiens.*

External Morphology and Jumping Ability

The most obvious difference between *R. clamitans* and *R. pipiens* in external morphology was their coloration. *R. clamitans* was basically dark green or brown above, with small, dark round spots, whereas *R. pipiens* was light gray, green or brown above with a bold pattern of larger light-bordered dark spots. Although *R. clamitans* was larger than *R. pipiens* in my study area (Figs. 1 and 2), Smith (1978) gave 101 mm as the maximum length for *R. clamitans* and 127 mm for *R. pipiens*, suggesting that adults of the two species are roughly equal in body size. *R. clamitans* and *R. pipiens* of the same SVL were equal in HLL and jumping ability (Figs. 1 and 2). *R. clamitans* possessed relatively more webbing on the hind feet than *R. pipiens* (Fig. 1).

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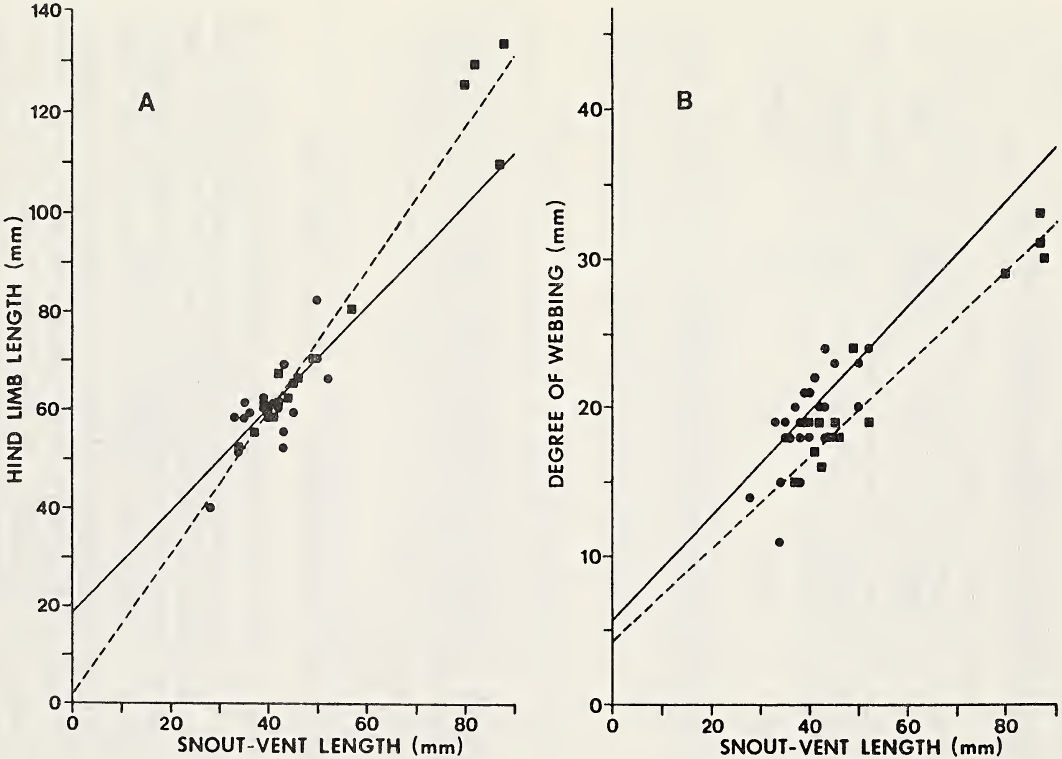

Fig. 1. Snout-vent length as a function of hind limb length (A) and degree of webbing (B) in *Rana clamitans* (squares, dashed regression lines) and *R. pipiens* (circles, solid regression lines). For *R. clamitans* (N = 15) in A, $y = 1.42x + 2.18$ ($R^2 = 0.96$); for *R. pipiens* (N = 25), $y = 1.02x + 18.64$ ($R^2 = 0.54$). For *R. clamitans* in B, $y = 0.31x + 4.16$ ($R^2 = 0.90$); for *R. pipiens* , $y = 0.35x + 5.64$ ($R^2 = 0.54$). The slopes of the regression lines are are the same in both A ($F = 3.34$; df = 1, 36; $0.10 > P > 0.05$ and B ($F = 0.19$; df = 1, 36; $P > 0.60$); the y-intercepts are the same in A ($t = 0.07$, df = 37, $P > 0.90$), but not in B ($t = 4.01$, df = 37, $P < 0.001$).

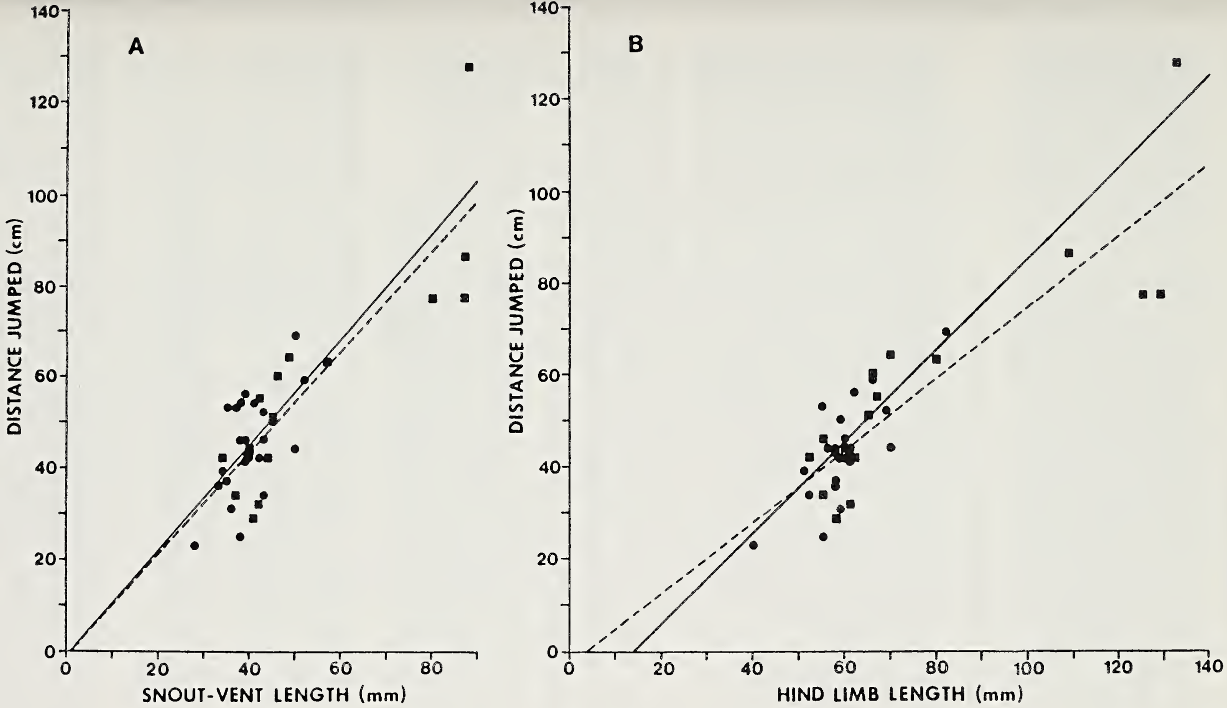

Fig. 2. Distance jumped as a function of snout-vent length (A) and hind limb length (B) in *Rana clamitans* (squares, dashed regression line) and *R. pipiens* (circles, solid regression line). For *R. clamitans* (N = 15) in A, $y = 1.11x - 1.54$ ($R^2 = 0.75$); for *R. pipiens* (N = 25), $y = 1.14x - 0.91$ ($R^2 = 0.35$). For *R. clamitans* in B, $y = 0.77x - 2.50$ ($R^2 = 0.76$); for *R. pipiens* , $y = 0.98x - 13.20$ ($R^2 = 0.49$). The slopes of the regression lines are are the same in both A ($F = 0.01$; df = 1, 36; $P > 0.90$ and B ($F = 0.53$; df = 1, 36; $P > 0.40$); the y-intercepts are the same in both A ($t = 0.56$, df = 37, $P > 0.50$) and in B ($t = 0.54$, df = 37, $P > 0.50$).

Discussion

The differences in escape behavior between the two frogs appear to be species-specific and innate, and are consistent with the habitat preferences of each frog. Although both species frequent the land-water interface, *R. pipiens* is more apt to wander away from water than *R. clamitans*, and therefore appears less dependent on standing water for escape and survival. The greater diversity of habitats occupied by *R. pipiens* is reflected by a greater variability in escape behavior.

R. pipiens frequents land more than *R. clamitans* and therefore may depend more strongly on saltation for escape. This might have been reflected in relatively longer hind limb length in *R. pipiens*, since Rand (1952) demonstrated that anurans with longer hind limbs were more efficient jumpers. Licht (1986) found this to be the case with the red-legged frog (*R. aurora*), which possessed relatively longer legs and jumped further than the more aquatic spotted frog (*R. pretiosa*). *R. aurora* also possessed less extensive webbing on its hind feet, another feature consistent with its more terrestrial habits. However, in the present study *R. pipiens* differed morphologically from *R. clamitans* only in its more disruptive coloration and less extensive webbing on its hind feet. Morphological similarity may account for the similarities between the species in jumping and diving ability.

The cryptic coloration of *R. clamitans* seems suited to the muddy banks along the water's edge where it often rests. The more disruptive pattern of *R. pipiens* probably helps break up its distinctive contour and thus camouflage it in the grassy areas where it frequently wanders.

The orientation of frogs with respect to the shoreline is enigmatic. Orienting toward water would seemingly facilitate escape by frogs which prefer to escape toward water. This appears to be the case for *R. pipiens*, which often escapes toward land, but not for *R. clamitans*, which most always escapes toward water. However, because significant differences between the species in their orientation behavior could not be demonstrated, conclusions are unwarranted.

The preferred orientation of frogs away from the predator when flight ceases probably facilitates further escape behavior should it become necessary. Both species of frogs seem reluctant to enter deep water, perhaps due to aquatic predators, scarcity of vegetative cover, or the greater distance to the pond bottom should diving be necessary. This may explain why frogs prefer to swim and orient toward land when surfacing from a dive.

The distress call emitted by a seized frog may startle a predator or serve a role in kin selection (Bogart, 1960; Licht, 1986; Duellman and Trueb, 1988). Licht (1986) found that *R. aurora*, which usually escaped toward land, emitted distress calls more frequently than *R. pretiosa*, which usually escaped toward water. Because the effectiveness of these calls would be greater if given in air rather than under water (Licht, 1986), they should be of greater benefit to *R. pipiens* since it frequents land more than *R. clamitans*. However, the frequency of individuals emitting distress calls is similar for both species. The ecology of anuran distress calls needs further study.

Both *R. clamitans* and *R. pipiens* are more likely to dive when pursued than when casually approached, suggesting that both species prefer to escape by jumping or swimming. The reluctance of frogs to dive is probably best understood in terms of energy expenditure: diving and holding one's breath almost certainly requires greater physiological and metabolic demands than jumping or swimming, and is advantageous only when escape by jumping or swimming is no longer possible. Diving is the escape behavior of last resort for both species of frogs; even *R. pipiens* that initially jumped toward land usually returned to the water and dived when pursued.

Because frogs respond selectively to the approach of a potential predator, escape behavior is a dynamic rather than stereotypic process. Frogs apparently assess the circumstances of each encounter with a potential predator, and adjust their behavior accordingly. Such flexibility in escape behavior allows frogs to respond appropriately according to the variability of a predator's approach, and allows frogs to discriminate between potentially dangerous and relatively harmless encounters. Variability in escape behavior may also confuse predators and help prevent predators from developing a search image. Most previous studies on the escape preferences of frogs considered only one type of predator approach (Gregory, 1979; Heatwole, 1961; Licht, 1986); only Hedeen (1972) considered two types of approaches, from land and from water, and found that mink frogs (*R. septentrionalis*) respond similarly to both approaches.

The ability of frogs to adjust their escape behavior in response to the approach of a predator should result in an increased survival advantage for individuals that respond appropriately. Experimental evidence indicates that salamanders and toads experience such an advantage when their behavior is adjusted according to the type of contact with ophidian predators (Ducey and Brodie, 1983; Hayes, 1989). Further investigation on the escape behavior of frogs is needed to determine which escape patterns are most effective in avoiding predation by natural predators.

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SIMOCEPHALUS SCHÖDLER, 1858 AND *SIMOCEPHALUS* GÜNTHER, 1858: RELATIVE PRIORITY AND CURRENT NOMENCLATURE

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Uncertainty of the relative priority of two homonyms published in 1858 periodically has haunted security of the now long-established cladoceran name *Simocephalus* Schödler (1858), of world-wide distribution, and the snake name *Mehelya* Csiki (1903) of subsaharan Africa. Those names are valid under the assumption that *Simocephalus* Günther (1858), a senior synonym of *Mehelya*, is junior to Schödler's identical name, which thus has priority. In fact, the actual date of publication of neither of the homonyms has been certain, and at various times each has been assumed to have priority, resulting in creation of several synonyms of each. We have attempted with reasonable success to determine definitively the actual dates of publication of both names, and here summarize the known facts. They indicate that the status quo should be maintained; with reasonable certainty, Schödler's name has priority over Günther's, as has been universally accepted for 50 years (since Neave, 1940: 197).

Günther's work (1858) was said by Norman (1903: 367), to have been published Oct. 9, 1858, fide personal communication with Günther. Sherborn (1934: 309) corroborated that assertion in his authoritative survey of the dates of publication of the catalogues of the British Museum. Angel and Chevey (1927: 44), on the contrary, stated that Günther's catalogue (1858) appeared Mar. 1. We have discovered that that date is the one printed at the end of Gray's Preface (p.vi) to Günther's book. Such imprints record dates of submission for publication, however, not dates of publication. Unfortunately, Neave (1940: 197) also accepted March as the date of publication, presumably on the strength of Angel and Chevey (1927). Schulze et al. (1954) cite no date, but list Schödler's name before Günther's, indicating priority; earlier generic indices did not list the names. On the basis of evidence available, and in the absence now of negative indications, clearly Oct. 9, 1858, has to be accepted definitively as the date of publication of *Simocephalus* Günther.

It seems reasonably certain that, as maintained by Csiki (1904: 267) and Poche (1904: 37), Schödler's article (1858) was published a few days before Sept. 22. It was included as the first few pages (3-28, pl.) of the annual report of the Ludovician State High School for the academic year 1857-1858. The rest of the annual report (pp. 29-40) is a detailed summary of activities through that academic year, with descriptions of courses, lists of library acquisitions, enrollments in courses, etc., ending with an announcement of the program for the public commencement to be held on Sept. 22, 1958. The 40-page report was apparently handed out to the audience at commencement. The inclusion of Schödler's article was presumably just a formal honor recognizing the scientific creativity of one of the school's instructors; Schödler was the physics teacher. No mention was made of it elsewhere in the report – not even in the commencement program.

We cannot state with absolute certainty that the annual report containing Schödler's article was indeed printed before Sept. 22, and then distributed, because no categorical statement exists to that effect. Internal evidence, however, including consistent verb tenses in various parts of the report (particularly on the last page, ending with a statement noting the dates for the coming school year), leaves no reasonable doubt. Without conclusive evidence to the contrary, there is no justification in altering the concepts of relative priority of *Simocephalus* Schödler and *Simocephalus* Günther, since the names for their genera have universally been accepted for 50 years, making them nomina venerata: *Simocephalus* Schödler for the world-side cladoceran genus (e.g. Idris, 1983; Negrea, 1983; Pennak, 1989), and *Mehelya* Csiki, 1903, for the African snake genus originally named *Simocephalus* by Günther (e.g. FitzSimons, 1962).

Mostly because of acceptance by some workers in the past of priority of Schödler's name, and by others of Günther's name, each name has acquired several synonyms, as follows:

Mehelya Csiki

Heterolepis Smith, 1847: pl. 55, text (preoccupied by *Heterolepis* Nees, 1834) (Hymenoptera).

Simocephalus Günther, 1858: 194 (preoccupied by *Simocephalus* Schödler, 1858).

Grobbenia Poche, 1903 (Sept. 21): 699 (preoccupied by *Grobbenia* Holdhaus, 1903 (July 28)) (Coleoptera).

Mehelya Csiki, 1903 (Nov. 15): 198 (substitute for *Grobbenia* Poche).

Siebenrockia Poche, 1904: 38 (substitute for *Grobbenia* Poche; a junior objective synonym of *Mehelya* Csiki, 1903).

Simocephalus Schödler

Simocephalus Schödler, 1858: 17.

Simosa Norman, 1903: 367 (substitute name for and junior objective synonym of *Simocephalus* Schödler, 1858).

Simodaphnia Angel and Chevey, 1927: 44 (substitute name for and junior objective synonym of *Simocephalus* Schödler, 1858).

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SIGNS AND SYMPTOMS FOLLOWING HUMAN ENVENOMATION BY THE MOJAVE RATTLESNAKE, *CROTALUS SCUTULATUS*, TREATED WITHOUT USE OF ANTIVENOM

Hobart M. Smith

Even a slight or moderate envenomation by *Crotalus scutulatus* (type A) produced life-threatening effects in the absence of antivenom in a healthy, 59 k man 77 years old, with delayed responses appearing several weeks after the bite.

It is not unusual for human envenomation by *Crotalus scutulatus* to be mild enough to justify not using commercially available antivenom because of sensitivity to horse serum, but such cases are not frequently reported. Nevertheless the signs, symptoms and recovery progress, all unmasked as they usually are by use of antivenom, are of special interest. The present report provides that information for one case, and some subjective details of sequelae over several months following the bite.

The subject was a 77-year old man of about 59 k, in reasonably good health, who requested that he remain anonymous. He received a glancing bite from one fang only of a snake he was attempting to catch, producing a 5 mm scratch (as the hand was jerked free from the snake) on the skin on the back of the hand superficial to the middle of the adductor muscle of the left thumb, about in the middle of the triangle of flesh between thumb and 1st finger. The scratch bled somewhat and was vigorously sucked, by mouth, but immediate pain like a cramp in the thumb, internal to the fang entry, made it apparent that at least some venom was injected. No first aid, other than suction, was applied - no constriction band, no incision.

The snake was a moderately large (± 85 cm) *Crotalus s. scutulatus*, apprehended about 3 km E Sonoita, Santa Cruz Co., Arizona, of the population of venom-type A (Glenn and Straight, 1989) of southeastern Arizona. The venom of this type is about 10 times as toxic in mice as that of type B, with a potent "Mojave toxin" lacking in type B venom, itself impressively toxic (Glenn and Straight, 1989). The neurotoxic effects so conspicuous in mice, however, are little evident in humans (Hardy, 1983).

A car and driver were immediately available; the subject therefore needed only to walk a few feet to the car, and without further exertion was delivered to the emergency room of the nearest hospital (in Sierra Vista) in about 45 min. He was quite calm throughout and ambulatory at the hospital. By that time some swelling of the hand, with pain, had occurred, but no particularly alarming signs were then apparent. However, shortly after being seated the subject experienced severe hypotension (shock), with systolic blood pressure dropping to 60 mm Hg. Intravenous fluid was administered, and continued for 22 hr. Upon reclining blood pressure normalized, but with the next hr two more episodes of hypotension occurred, each short-lived and passing spontaneously within a few minutes without further treatment.

Administration of antivenom was considered, but a test for sensitivity to horse serum revealed an allergy to it; the test site remained irritated for 48 hr. The subject had received antivenom for treatment of a copperhead bite when 16 or 17 years old, and presumably then developed sensitivity to horse serum. Since the bite was apparently minimal, a decision was made to apply no new treatment, other than tetanus antitoxin, unless signs or symptoms became alarming. Nothing more proved to be needed.

However, heart rate became elevated after the initial hypotension episodes, to the low 90's as opposed to the normal resting 60/min., and blood pressure remained high (±150 x 110). In 12 hr both were stabilizing near normal, and in 18 hr were normal.

The only other general physiological response was an attack of diarrhea that pretty well emptied the intestines within 6 hr. No digestive problems occurred subsequently.

Diplopia (double vision) had become apparent after 12 hr, persisted with diminishing prominence for 72 hr, and thereafter did not return. No ptosis (drooping eyelids), dysphagia (difficulty in swallowing) or dysarthria (slurring of speech) was noted.

Edema was very prominent after about 3 hr post trauma. Actually the swelling of the hand had diminished slightly within 1.25-2.5 hr, but after 3 hr swelling progressed steadily, with accompanying pain, reaching its maximum after 36 hr, when the subject was released from the hospital, and remaining the same for another 36 hr as the subject began to resume normal activity. A slow recession of edema then began. Not for 11 days after the bite occurred was the edema completely gone. Its recession was accompanied by increased local temperature.

At its maximum, the edema involved the whole arm; fingers, wrist, and hand were the worst, swollen drumhead tight. Pain was not particularly a problem, but was most acute as fingers or wrist were flexed. The whole latissimus dorsi was tender and sore, although no swelling was evident in shoulder or back. Even after 7 days the triceps and latissimus dorsi remained sore. There was no bleb formation.

A conspicuous cytolytic effect, evident almost as soon as blood tests were initiated (1.5 hr after the bite), was a surprising fragility of veins on the bitten arm, greatly interfering with blood extraction. Since the IV catheter was in place for 22 hr on the right arm no blood could be extracted from it for that period, although it was afterward; hence foot vessels were utilized once for blood extraction.

Ice was briefly applied to the edematic hand and forearm, which were kept elevated most of the time while bedridden and for two days thereafter, but objections by the subject, based on many contraindications in the literature (e.g., Russell, 1983), limited the exposure all told to less than an hour over the first 8 hr and none was attempted thereafter.

After the edema had largely disappeared, numbness became evident on the dorsal surface of the entire thumb and into the wrist; the entire back of hand, thumb, and preaxial surface of the wrist tingled constantly and were especially sensitive to rubbing. Occasional flashes of pain coursed down the postaxial margin of the thumb and on the ventral surface of wrist and forearm. Blood vessels of the bitten arm remained apparently weak-walled, subject to engorgement and some associated pain when dangled; appreciable comfort was provided by elevation.

An unexpected development after 22 days was a partial return of edema, not as great or as extensive as before, but much more painful. On its second round it was restricted to the wrist, ventral surface of the forearm, the thumb and preaxial part of hand. The edema was initially not prominent. It centered upon, but was not confined to, an area where the tendon of the palmaris longus was removed, ca 30 yr previously, from the forearm and substituted for the tendon of the flexor pollicis longus that had accidentally been cut. The operation presumably altered normal lymphatic channels, in turn interfering with local drainage.

The renewed swelling, slowly worsening for 10 days, was accompanied by a painful ache and increased local warmth, and by enlargement of several nodules, becoming hard and tender, on the ventral surface of the forearm and on dorsal surface between thumb and first finger.

On the 7th day, aided by use of a gauze bandage, the ventral forearm edema was greatly reduced from its previous baglike appearance, but elsewhere the edema continued to increase slowly, with relatively little pain during most of the day, excruciatingly severe at night. An elastic cloth bandage or glove did little to impede the progressive swelling or pain.

One 200 mg tablet of ibuprophen (Advil) was taken on the 9th and 10th nights, when the pain was worst, but no other analgesic was taken at any time subsequent to the original bite. The progressive edema of hand and wrist stabilized on the 11th day, when the pain started to subside. The swelling diminished thereafter very slowly, aided for a time by use of a snugly fitting, cloth glove, which always allowed fairly free movement at all joints; use of the cloth bandage and tight gloves was abandoned because it impeded joint movement, which became painful when mobility was restored. For a long time, a tingling sensation responded to touching the skin on the preaxial half of the dorsal surface of the hand; throughout the same area the dorsal skin was numb, especially on the thumb and first finger. Extreme flexion or extension of the wrist was painful, and the wrist at all times felt like a bottleneck, as though wearing a constricting band. The nodules previously affected remained enlarged and hard.

Recall that within about 4 days of the initial bite, the subject carried on essentially his normal activities, sometimes rather strenuous or stressful, or both. He felt more or less normal, with only the local effects of the bite remaining, after three weeks, as described in the preceding. A reversal began approximately as the second episode of swelling appeared, with vague feelings of depression, weakness and an inability at times to maintain a comfortable level of metabolism, exacerbated by the pain associated with the recurrent edema and by some annoying cold sores. Although susceptible to frequent cold sores throughout life, the subject had not experienced any for about a year – the longest he could remember – following use of a new drug with the last attack, until the onset of the recurrent episode of edema. During the first two weeks of that episode, two recurrences of cold sores occurred, and none since (10 mo later).

On the 15th day after the recurrent edema appeared, after its pain had subsided but long before much of the swelling had disappeared, the weakness the subject had been feeling became accentuated and culminated with a severe attack of paroxysmal atrial fibrillation. Fortunately he was with his car at the time, and but a few blocks from a hospital, where he reported to the emergency room. Immediate treatment quickly brought the heart rate down from 280/min to 150/min ± 25), and about 3 hr later the rate snapped down to the subject's normal 60's/min. Released after 32 hr, the subject has seemingly recovered fully, although he remains under a medication regime intended to prevent recurrence of fibrillation.

The coincidence of the second episode of edema, certainly resulting from the snakebite, with the atrial attack, recurrence of cold sores, metabolic deficiency, and depression, suggest a causal relation, although proof is lacking. Nevertheless, the advanced age and reduced vitality of the subject could very well have predisposed him to residual effects of the snake venom that would be totally unexpected in a younger, more resilient person. Any connection between the snakebite and the later physiological aberrations (except for the recurrent edema) remains problematical, but merits mention of possibility, however remote it may prove to be. Certainly the obvious effects of the envenomation – the edema, numbness, tingling response to tactile stimulation, and muscular weakness of the hand particularly of the thumb – very gradually subsided, so that by the end of 4 mo after the bite, all had disappeared completely. No hidden effects of more tenacious nature, e.g. blood vessel fragility or neurological aberration, are known to exist.

This case suggests that even if use of antivenom is contraindicated in treatment of bites by *Crotalus s. scutulatus* of venom type A, treatment with IV fluids may be vital to counteract venom-induced hypotension, as pointed out by Hardy (1986). Other effects, both immediate and delayed, either readily apparent or insidious, should be monitored for 6-8 weeks, and can be expected to vary with age and state of health.

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PRIONODACTYLUS AMPUEDAI (SAURIA: TEIIDAE): A NEW LIZARD RECORD FOR COLOMBIA, WITH TAXONOMIC COMMENTS ON THE SPECIES

Enrique La Marca and Juan Elías García-Pérez

On the ninth of August of 1987 we collected a teiid lizard about 5 km N Herrán, 1725 m, on the road to Chinácota (Departamento Norte de Santander, Colombia). The specimen (IND- R [INDERENA] 3709) closely agrees with the description of *Euspondylus ampuedae* Lancini, 1968. The taxon was previously unknown from Colombia (Ayala, 1986); accordingly, this is the westernmost locality and the first Colombian record for the species, which was originally described from the vicinities of Villa Páez, ca. 2000 m, Estado Táchira, Venezuela.

In a revisionary work by Uzzell (1973), *Euspondylus ampuedae* was transferred to the neotropical genus *Prionodactylus*. In addition, the species was tentatively synonymized (Uzzell, 1973:7) with *Prionodactylus vertebralis* (O'Shaughnessy, 1879). We have examined, besides IND- R 3709, the holotype (MCNC [Museo de Ciencias Naturales Caracas, Venezuela] 5223) and three previously unreported specimens from the type locality (ULABG [Colección de Anfibios y Reptiles del Laboratorio de Biogeografia, Facultad de Ciencias Forestales de la Universidad de Los Andes, Mérida, Venezuela] 2887-2889) of *Prionodactylus ampuedae* and believe that the taxon deserves restoration of specific status. Uzzell based his taxonomic decision, synonymizing *P. ampuedae* with *P. vertebralis*, mainly on the presence of a pale lip line in the former and a consideration that most of the other described features of the types of *P. ampuedae* could be matched in the sample of *P. vertebralis* that he examined. From Uzzell's descriptions, it would also seem that both *P. ampuedae* and *P. vertebralis* may or not have a middorsal pale line - character states that could also suggest conspecificity of the samples. In the following, we discuss the taxonomic importance of these characters.

Although the presence of a pale lip line in *P. ampuedae* is reported elsewhere in the genus, its straight shape may be useful to help distinguish the members of that taxon from *P. vertebralis* and other members of the genus (Table 1). Uzzell's (1973:7, 17) assertion that the male paratype of *Euspondylus ampuedae* has a middorsal pale stripe could be misleading. None of the types of this taxon that we examined, nor additional topotypes or the new Colombian record, have a middorsal pale stripe. We rather believe that there was a mistranslation of the Spanish description of *E. ampuedae*, in which Lancini explicitly stated that the male paratype of that taxon has a dorsolateral black band and a short black vertebral line[1]. The absence of a pale dorsolateral line in *P. vertebralis* may likewise be questioned. The only example, out of the about 200 specimens of *P. vertebralis* worked by Uzzell (1973), in which the middorsal pale line is absent is a Peruvian specimen (LACM [Los Angeles Co. Museum] 55881) which also has at least several characters (loreal absent vs. loreal present; undivided translucent disc in lower eyelid vs. lower eyelid disc divided into three to five parts; and other characters mentioned in Table 1) suggesting that perhaps LACM 55881 could represent a different taxon from *P. vertebralis*. With this in mind, it seems that all *P. vertebralis* have a middorsal pale stripe, whereas it is lacking in all *P. ampuedae* studied to present. With that distinction confirmed, it seems apparent that *Prionodactylus ampuedae* represents a taxon different from *P. vertebralis*. Some other characters that may be helpful in distinguishing *P. ampuedae* from the remaining species in the genus are given in Table 1.

Besides the taxonomic restoration proposed above, we suggest a change in the proper ending of the specific name of *P. ampuedae*. The patronymic noun *ampuedae* is an incorrect original spelling, according to article 32 *c i* of the 1985 International Code of Zoological Nomenclature, since it contravenes provision *ii* of the article 31 *a* that states that " a species-group name, if a noun in the genitive case formed directly from a modern personal name is to be formed by adding to the stem of that name *-i* if the personal name is that of a man...; the stem of such name is determined by the action of the original author when forming the genitive". Lancini (1968:5) clearly stated that the species was named after his collector, Mr. Ramón Ampueda, and since (under rules in effect up to 1968) the name Ampueda was not accepted as Latin, the spelling *ampuedai* is a justified emendation of the original spelling.

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We thank Dr. Ramón A. Lancini and Lic. Pedro Delgado (MCNC) for provision of working space and facilities for the junior author to study the holotype of *Euspondylus ampuedai*. Dr. José Vicente Rueda generously gave us a museum number to catalog the Colombian specimen in the Colección

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[1] ..."el macho (MCNC No. 5263)...Posee una banda dorso-lateral negra y una linea vertebral corta también de color negro" (Lancini, 1968:5).

de Reptiles del Instituto Nacional de los Recursos Naturales Renovables y del Ambiente (INDERENA), Colombia. Dr. R. A. Lancini and Dr. Juan Manuel Renjifo provided pertinent literature. Dr. Hobart Smith (University of Colorado) kindly reviewed and commented upon an early version of the manuscript. This work was supported in part from Grants CONICIT S1-2053 and CDCHT-ULA Fo-223-89 to the senior author.

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Table 1. Comparative matrix of some distinguishing traits between *Prionodactylus ampuedai* and the remaining members of the genus. Abbreviations as follows: MBA: midbody annulus scale count; PVL: pale vertebral line; PLL: pale lip line; DLPL: dorsolateral pale line; FP: femoral pore count; F: females, M: males.

	MBA	PVL	PLL	DLPL	FP
ampuedai	27-30	ABSENT	STRAIGHT	ABSENT	6-18 (F) 10-20 (M)
argulus	29-41	ABSENT	STRAIGHT	ABSENT	0-15 (F) 12-25 (M)
dicrus	38-43	PRESENT	CURVED	PRESENT	7-11 (F) 20-25 (M)
eigenmanni	29-31	ABSENT	ABSENT	ABSENT	0(F) 12-15(M)
manicatus manicatus	37-52	ABSENT	CURVED	PRESENT	14-28 (F) 21-30 (M)
manicatus bolivianus	33-41	ABSENT	+	?	3-9 (F) 15-19 (M)
vertebralis	31-45	PRESENT	CURVED	ABSENT	0-16 (F) 0-16 (M)
? *vertebralis* (LACM 55881)	28	ABSENT	?	PRESENT	0 (M)

+A pale inconspicuous lip line beginning under eye.

ENRIQUE LA MARCA, Universidad de Los Andes, Facultad de Ciencias Forestales, Laboratorio de Biogeografía. Apartado Postal 116, Mérida 5101-A, Venezuela.

JUAN ELIAS GARCIA PEREZ, Universidad de Los Andes, Facultad de Ciencias, Departamento de Biología, Mérida 5101, Venezuela.

NEWS & NOTES

ROBERT WILLIAM REESE, 1917-1990

Hobart M. Smith

Frailty of life is a fact that we typically, although certainly not always, come to appreciate gradually with the passage of time as one by one our tethers to others attenuate (or not) and abruptly part. Another tether, however tenuous or staunch it may have been for countless colleagues, partners, friends and former students, parted Jan. 19, 1990, with the passage of Robert William Reese, 72, quietly in his sleep at his home in Austin, Texas. He was blessed with a rare combination of independence, originality, spirit, humbleness, gentleness, dutifulness, scholarliness, empathy and leadership by example. Honor and courage were never flaunted, but were unshakeable attributes, and he insisted on maintenance of high standards by himself and his associates. Few indeed have served their country as long and faithfully as he did, and yet in addition earned a Ph.D. in order to maintain a second career in university teaching and research.

We in academia are familiar with the hurdles and opportunities that that life entails, but we are rightfully awed by a successful colleague who has led also a highly successful life in a completely different world. For Bob Reese that ancillary life was in the U.S. military forces. He enrolled at Lehigh University, Bethlehem, Pennsylvania (where his father, William D. Reese, had graduated), completing requirements for a Bachelor's degree in 1941. As an ROTC enrollee he was called to active duty in the Army as a 2nd Lt. in the infantry. Because he already had a pilot's license, flying a Piper Cub, he asked for and was granted a transfer to the Air Corps in 1942.

Assigned as a Student (Commissioned) Officer to Moore Field, Mission, Texas, he trained Cadets (his first teaching experience) and was himself trained. After two years, he was sent to England with the 10th Fighter Squadron in the 9th Air Force, flying P-47 fighter-bombers. Before being rotated back to the U.S. in April, 1945, at the rank of Captain, he flew more than 80 missions over Germany and France, took part in the D-day operations, and was awarded both a Distinguished Flying Cross and an Air Medal with Clusters.

That was not the end of Bob's military service. But after having been transferred from one station to another – Florida, Arizona, Texas – and having no challenge in prospect, he resigned from the Air Force and entered the University of Illinois in 1947, receiving a Bachelor's degree in chemistry the same year and a master's degree in ecology in 1949. Receiving a Research Fellowship at the University of Kansas, he continued there for his Ph.D. in stream biology. However, being in the Air Force Reserve, he was recalled in March, 1951, during the Korean crisis, and was ultimately promoted to the rank of Major. He was assigned to an Armament and Electronic Maintenance Squadron and eventually became Squadron Commander. In 1956 he was transferred to Japan (Ashiya A.F.B. on Kyushu). From there he flew cargo and weather planes a great deal to or from bases all over the Orient – Korea, Thailand, Philippines, Hong Kong, Guam, Taiwan, Japan – receiving a Command Pilot rating in the process.

Having spent so much time on demand in the military, Bob concluded that it would be best to complete his career there. He retired in 1966.

Although retired from an illustrious career in the military, Bob was always a man of action. He chafed at inaction, either physical or mental. The physical part was satisfied, at least in part, by hunting and fishing, especially in Colorado, where he became an expert. Game bird to big game hunting were regularly on his schedule, and between seasons he long supplemented his academic endeavors with herpetological collecting. Camping was as natural a way of life as home.

The mental challenge came in the form of completion of his Ph.D. degree. Stationed toward the end of his military career at Lowry A.F.B. in Denver, he began work toward that degree at the nearby University of Colorado in 1964, under the supervision of Dr. T. Paul Maslin. That was not his first contact with herpetology, however. I had met him at the University of Illinois in 1948 while he was a student there, after his discharge from the Air Force at the end of 1946. He maintained an interest in herpetology from that time on, and with the availability of Maslin at the University of Colorado, when he was ready to pursue again a Ph.D. degree, that interest became his research focus thereafter.

Bob was catholic in his interests and abilities, however, and he spent much of his military career as a teacher of mathematics, electronics and engineering. That experience plus his successful university training in chemistry, ecology and stream biology, even before he enrolled at the University of Colorado, indicated a high level of intellectual ability.

It did not always seem so. Born Aug. 3, 1917, in Bridgeport, Connecticut, he progressed at a normal rate through public grade and junior high schools in Illinois and Michigan, and graduated from Manlius School in Manlius, New York, in June, 1934. After a year at Loyola University in Chicago, he enrolled at Lehigh University, in 1935. During a break from 1937 to 1939, he worked as a student engineer for Wagner Electric Corporation in St. Louis, Missouri. Graduation requirements at Lehigh University were completed in 1941.

In spite of the intrusion of military service, Bob's interest in an academic career remained unquenched. Every break was used to garner more credits toward the ultimate goal of a Ph.D. During the second term in the Air Force, when stationed near an academic center, he would squeeze in time to take one or two courses. Thus he received credit in Marine Biology at the Marine Biological Station in Ocean Springs, Mississippi, and in a course in "Problems of Modern Education" at Washburn University, Topeka, Kansas. While at his last Air Force Base, in Denver, he started taking courses at the University of Colorado long before he retired in 1966. Immediately thereafter he enrolled full time at the University, assisted in several courses, and was awarded his Ph.D. in August, 1969, at the age of 52. His dissertation, on which he devoted a great deal of time in the field for several years, was on the distribution, taxonomy and natural history of the tiger salamander (*Ambystoma tigrinum*) in Colorado. A very brief summary of it was published in 1973.

Although Bob had published ten articles before then, teaching satisfied his academic creative drive thereafter. He was devoted to pedagogy, always available to students whenever they wanted help, either at home or at school. He taught mostly at St. Edwards University at Austin, Texas, where he started in 1969 and where he retired at the age of 68 in 1985, although he resigned in 1971 to be with his mother, who was very ill, in Denver. After she died he taught three years at the University of Colorado in Colorado Springs, acting as departmental chair in biology one year. Throughout this time he maintained contacts with St. Edwards University, and when his original position there became vacant, he was welcomed back. Even after retirement, he worked twice a week, without compensation, through the 1986 and 1987 academic years, to help out with laboratory courses in which the University was short-handed.

A list of Bob's publications is appended. His interest in research did not cease after he received his Ph.D., but, like many others, he became totally absorbed in the responsibilities of teaching. His teaching load was always heavy, leaving little free time. A rotation scheme kept him always busy with Genetics, Evolution, Comparative Anatomy, Vertebrate Embryology, Invertebrate Zoology, Vertebrate Zoology and General Biology.

Although free-spirited as a youth, Bob's heritage inevitably dominated his personality. He was the only child of William D. Reese and his wife Juliette A. Teste, who married in Oct., 1916, in Bethlehem, Pennsylvania, the year William graduated from Lehigh. He was an automotive engineer who, after a stint with General Motors, became head of engineering at International Harvester. He was credited with designing the half-track used in WWII, and the 4-wheel drive International Scout. His expertise made him a valued consultant in Washington. Thus Bob was in a position where he could very easily have rested on his father's laurels and financial security. To his credit, he insisted on making his own way, as his father had done before him.

Soon after being sent to the Air Force Base in Mission, Texas, in 1942, he met Margaret Bonnycastle, who lived nearby in McAllen and worked as secretary for the Commandant at the base, and they were married Nov. 11, 1942, in McAllen. They have two children, Anne Bonnycastle (now married to Steven Crews), and William D. Reese (now married to Suzanne K. Brown). There are four grandchildren - Michelle Reese, Patricia Reese, Margaret Crews and Hannah Crews.

Bob was an exceptionally gifted person not at all dismayed by abstruse technicalities and was blessed by ingenuity, manual dexterity and and inventiveness, as well as a drive to do the best possible under any circumstances. Thwarted in his academic ambitions, by the intervention of WWII and the Korean War, his achievements nevertheless stagger the imagination: an engineering and electronic expert, a skilled pilot, an outstanding war hero, a dedicated teacher, a devoted family man, an inveterate outdoorsman, and a confirmed professor who achieved that goal along with his Ph.D.

The discipline of herpetology has never been more honored, and neither have I as a long-time friend. His ashes lie, as he would wish, near one of the Colorado mountain lakes that he loved.

Publications of Robert W. Reese

Reese, Robert W.

1950. The identity of the salamander *Gyrinophilus danielsi*, with description of a new subspecies. Nat. Hist. Misc., (63):1-7, figs. 1-2.

1953. An additional record of *Microhyla elegans* (Boulenger). Herpetologica, 8(4): 182.

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Department of Environmental, Population and Organismic Biology, University of Colorado, Boulder, Colorado 80309-0334.

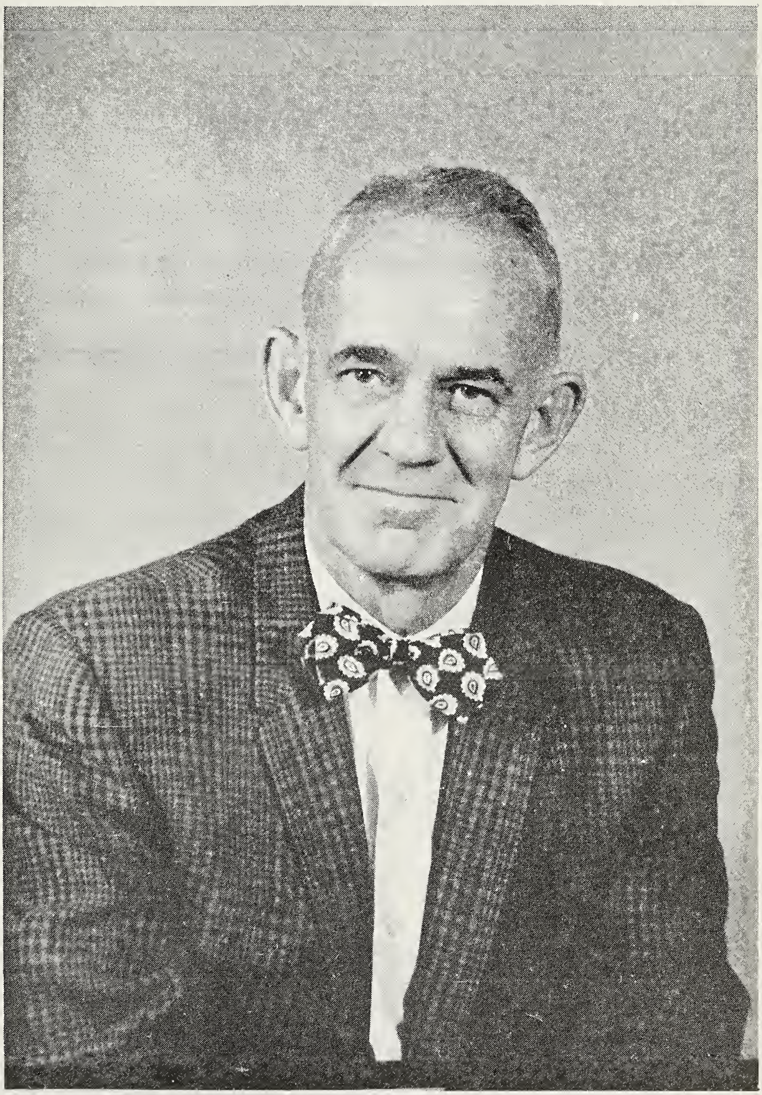

Fig. 1. Robert W. Reese, about 1976-1977

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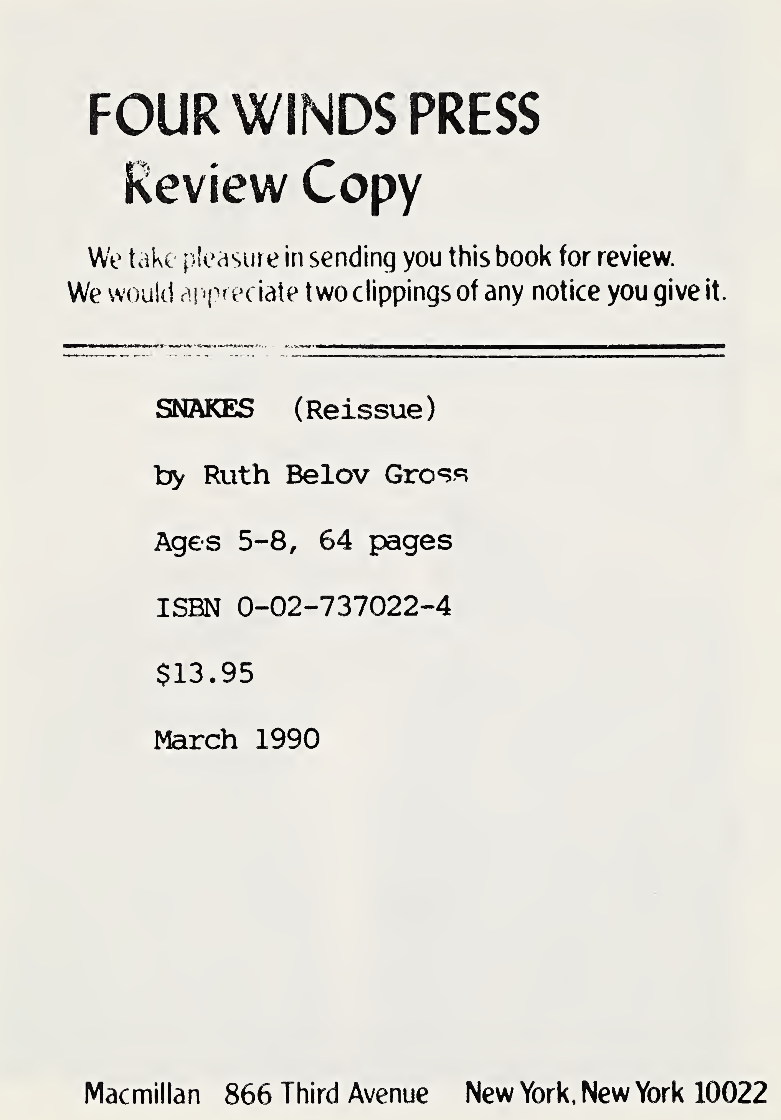

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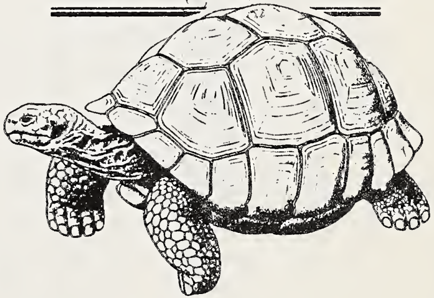

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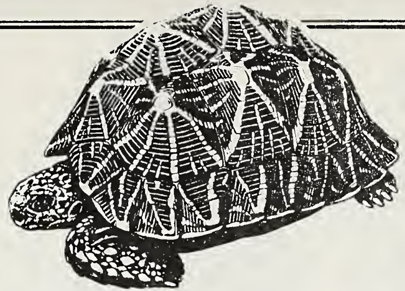

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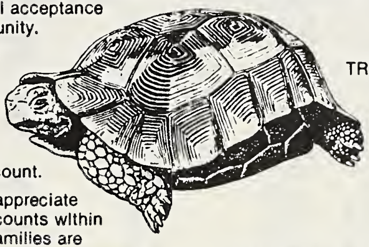

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NEWS & NOTES:

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Wildlife 2001: Populations is an international conference intended for research workers and agency personnel whose interest is the science, conservation, and management of vertebrate populations (exclusive of fish and primates). Papers will assess the state of the art and set the agenda for applied wildlife population work on the verge of the 21st century. It is a followup of the highly successful Wildlife 2000, which emphasized habitat modeling, and a companion publication will be produced.

The conference will be held July 29 through 31, 1991, at the Oakland Airport Hilton Hotel in Oakland, California. This hotel is a low-rise hotel with outside courtyards and gardens, and is away from the downtown area, within a mile of the Oakland Airport. Free parking and free shuttle buses to the airport and rapid transit (BART) give easy access to the greater San Francisco Bay Area.

Morning General Sessions, with chairs, will be: Methods, Gary White; Modeling, Carl Walters; and Threatened Species, Kathy Ralls. Afternoon sessions include: Small Mammals, Lloyd Keith; Marine Mammals, Chuck Fowler; Waterfowl, Doug Johnson; Overabundant Populations, Fred Wagner; Herps, Norman Scott; Large Herbivores, Fred Bunnell; Game Birds, John Roseberry; Seabirds, David Nettleship; Passerine Birds, Barry Noon; Large Carnivores, Maurice Hornocker; Raptors, Stan Temple; and Furbearers, Bill Clark.

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Gary Casper	Current Status of Some rare herps in Wisconsin
John Coakley	Breeding, husbandry and conservation of leopard and star tortoises
Joe Collins	Trials and tribulations of writing the 3rd ed. of the Peterson field guide
Norm Haskell	Over-wintering alligators at St. Louis Zoo
Ron Humbert	Head starting wood turtles
Dan Keyler	Venomous reptile bites in the midwest
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2:00 to 6:00	Registration, exhibits, and live animals
6:00 to 7:00	Dinner (on your own)
7:00 to 9:00	Welcome, speaker , MHS slide show.
9:00 to12:00	Ice breaker social and Museum visit.

Saturday, October 13

8:00 to 9:00	Registration and Coffee
9:00 to11:45	Speakers
11:45 to 1:30	Lunch (on your own), exhibits
1:30 to 4:30	Speakers
5:30 to 7:00	"Happy Hour"
7:00 to 8:00	Banquet
8:00 to ???	Auction.

Sunday, October 14

10:00 to 12:00	Exhibits, live animals.
12:00 to ???	Tour of Museum, Minn. Zoo, and Private Collections

Exhibitors and Animal Sales

MHS has arranged for a space for commercial exhibitors and live animal sales at the Bell Museum. NO arrangements have been made with the hotel for animals and no animals are allowed in the hotel. Persons interested in space should note it on their registration and send in their request before 15 September. The committee chair will contact interested parties. All participants in these two events will be asked to make a donation to the auction.

Auction

An auction will be held after the Saturday night banquet. Joe Collins, auctioneer extrodinaire will be conducting. Herp related items are needed to help in this effort.

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NOTES:

Society Publication

Back issues of the Bulletin of the Maryland Herpetological Society, where available, may be obtained by writing the Executive Editor. A list of available issues will be sent upon request. Individual numbers in stock are $2.00 each, unless otherwise noted.

The Society also publishes a Newsletter on a somewhat irregular basis. These are distributed to the membership free of charge. Also published are Maryland Herpetofauna Leaflets and these are available at $.25/page.

Information for Authors

All correspondence should be addressed to the Executive Editor. Manuscripts being submitted for publication should be typewritten (double spaced) on good quality 8 1/2 by 11 inch paper with adequate margins. Submit original and first carbon, retaining the second carbon. If entered on a word processor, also submit diskette and note word processor and operating system used. Indicate where illustrations or photographs are to appear in text. Cite all literature used at end in alphabetical order by author.

Major papers are those over 5 pages (double spaced, elite type) and must include an abstract. The authors name should be centered under the title, and the address is to follow the Literature Cited. Minor papers are those papers with fewer than 5 pages. Author's name is to be placed at end of paper (see recent issue). For additional information see *Style Manual for Biological Journals* (1964), American Institute of Biological Sciences, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016.

Reprints are available at $.03 a page and should be ordered when manuscripts are submitted or when proofs are returned. Minimum order is 100 reprints. Either edited manuscript or proof will be returned to author for approval or correction. The author will be responsible for all corrections to proof, and must return proof preferably within 7 days.

The Maryland Herpetological Society
Department of Herpetology
Natural History Society of Maryland, Inc.
2643 North Charles Street
Baltimore, Maryland 21218

Natural History Society of Maryland
Maryland Herpetological Society

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DEPARTMENT OF HERPETOLOGY

THE NATURAL HISTORY SOCIETY OF MARYLAND, INC.

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EASTERN SEABOARD HERPETOLOGICAL LEAGUE

31 DECEMBER 1990

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Volume 26 Number 4 December 1990

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BULLETIN OF THE
mdhs

Volume 26 Number 4 December 1990

The Maryland Herpetological Society
Department of Herpetology, Natural History Society of Maryland, Inc.

Executive Editor............Herbert S. Harris, Jr.

Steering Committee

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Membership Rates

Membership in the Maryland Herpetological Society is $16.00 per year. Foreign $20.00/year. Make all checks payable to the Natural History Society of Maryland, Inc.

Meetings

The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May—August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

HERPETOLOGICAL OBSERVATIONS ON TIBURON PENINSULA, HAITI

R. Earl Olson

In connection with academic duties, and in coordination with The Organization for Tropical Research, I have made herpetological observations in Haiti, particularly on the western peninsula, to produce a working guide for use in the classroom. To be more useful to other workers, the study is herein expanded to include the area with boundaries at Port Salut and Les Anglais to the west, Cavaillon on the east, the southern border of Department de la Grand Anse at the north, with the south represented by an imaginary line connecting Ile à Vache and Ile Pelantin in the Caribbean.

Because of the impoverished and humanly overridden condition of the land, amphibian and reptilian populations, except those which tolerate or thrive in presence of man and severely altered habitat, are scantily, if at all represented (Olson, 1990, Bull. Chicago Herp. Soc., p. 31).

Despite the ecological condition of much of the countryside, enclosed courtyards, usually involving ample vegetation and adequate retreats, offer exceptional micro-habitats for small assemblages of herpetofauna. Most commonly occuring species in such habitat in Les Cayes include *Eleutherodactylus pictissimus, Osteopilus dominicensis, Sphaerodactylus copei, Sphaerodactylus cinereus, Gonatodes albogularis, Anolis cybotes, Anolis distichus*, and *Anolis coelestinus*. Thus, cryptic and emergent fauna are quite well represented.

Localities offer various habitat, from tropical lowlands to subtropical grasses and second growth scrub, along with extensive agricultural growth such as rice paddies, orchard, and open pasture. Hilly woodland occurs in Ducis, Camp Perrin and Poste Avance. High in Massif de la Hotte - near Dichiti and Patate - there exists forest, much of which includes large trees, with some pine glade. Most growth consists of evergreen or annuals. The elevation rises from sea level to 2200 m - Pico de Macaya.

SPECIES ACCOUNTS

Amphibians

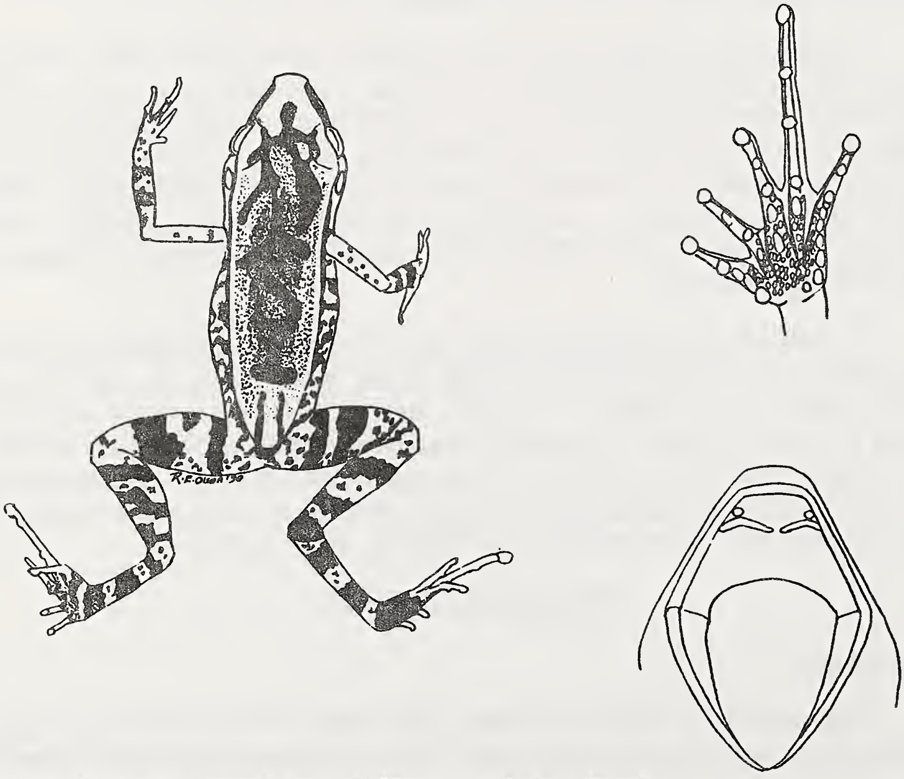
Bufo marinus - Two specimens were taken DOR 3 km E Les Cayes, and another seen 2 km N Camp Perrin. These toads usually are abundantly encountered in mainland tropics, but are relatively scarce here. None was seen on streets in towns.

Eleutherodactylus pictissimus - This frog is common but locally occuring. Often found hiding beneath objects in enclosed courtyards, they emerge to forage on rainy nights.

Color is generally olive-green, boldly mottled between and beneath a pair of light dorsolateral stripes. There is always a dark inter-orbital bar and a bold dark stripe between nostril and eye. The posterior surface of the femur is heavily mottled.

These frogs are immaculate white beneath with dusky spotting on the distal segment of the hindlimbs. The general effect is a boldly mottled frog.

The smallest specimen (No. 11948) is 18 mm SVL, the largest (No. 11952) 36 mm. For 23 specimens, mensural data are; SVL - $\overline{X}$ = 27.2 (18-36); femur - $\overline{X}$ = 12.2 (8-15); femur/SVL - $\overline{X}$ = .448 (.400-.546).



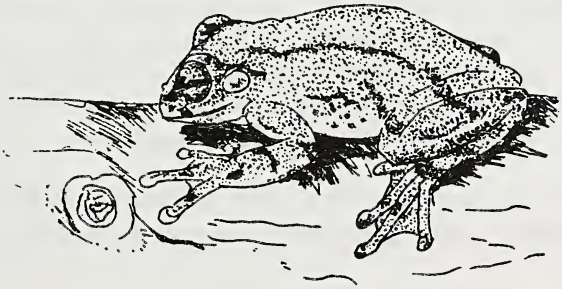
Eleutherodactylus pictissimus: – #11939, Les Cayes, Haiti.

Osteopilus dominicensis - Most omnipresent and abundant, this frog occurs in courtyards, thatch of buildings, and in woodlands. Many dozens of individuals typically inhabit relatively small courtyards. They breed in almost any available fresh water, including ponds, open clusters, rain troughs and ditches. Calling begins in March, continuing through November. The call is a hoarse "quok - quok - quok" 4 to 5 per series.

Generally these treefrogs are buffy gray to dull tan dorsally, the intensity of hue varying in response to atmospheric conditions. The ground color is variously plain, flecked, or darkly mottled. Dorsal surfaces of the limbs are barred on proximal and distal elements. Posterior surfaces of thighs - in about equal occurrence - plain, flecked, or blotched.

Size of the samples varies from 23 to 86 mm SVL ($\bar{X}$ = 53.9). The femora vary from 11 to 39 mm ($\bar{X}$ = 26.1).

Tadpoles of this species were found in September, among watercress in a shallow trickle less than 100 ft. from the Caribbean beach.



Osteopilus dominicensis: – Les Cayes, Haiti.

Reptiles

Sphaerodactylus copei - This most commonly observed species of gecko in the area occurs in most courtyards. Specimens were observed in and from all study plots, except those with unsuitable habitat. Color and pattern variation is great, varying from the female with head green heavily reticulated with black, and the body olive green with tomato-red spots, to those which are boldly barred. Males are relatively plain olive gray as adults, with the head butter-yellow.

In a sample of 37 specimens, 36 are females. Among the female sample, 18 have a plain dorsum, mottled black (or loose reticulum) on head and throat, 13 bear a collar with yellow spots on black background, 5 juveniles bear broad bands with darker borders (4 specimens) and 2 with dark collars bearing yellow spots.

Adults average 35.8 mm SVL (28-41) while juveniles average 21.3 (19-23), with tail length (in specimens measured) $\bar{X}$ = 27.3 (24-32). Dorsals and ventrals from axilla to groin are 20.2 (17-23), ventrals 29.4 (26-31), 4th toe lamellae 14.4 (12-17), internasals 1 (except 2 in No. 11895), and supralabials to mid-eye generally 4-4, but 5-5 in No. 11851, and 4-5 in No. 11895.

These lizards hide beneath almost any concealment sufficiently close to adjoining surface, and containing adequate moisture. They are active day and night in suitable conditions.

Sphaerodactylus cinereus - The pale gecko is less common than is the preceding species, but the habitat is quite similar. The color is gray with light cream or yellow spots; occasional specimens are plain. The dorsum of the head bears a darker reticulum. Dorsals are smaller than ventrals and are medially raised rather than flat as are the ventrals.

A juvenile is quite different, being off-white dorsally, bearing bold black cross-bands (7, axilla-groin) with dusty-rose limbs and tomato-orange tail.

Adults average 32.1 (28-34.5) mm SVL, a juvenile 18 mm. There are 4 supralabials (to mid-eye) in all.

Gonatodes ablogularis - This gecko is abundant in the Les Cayes area, whence all of the specimens orginate. Unlike the situation with *Sphaerodactylus copei*, males of *Gonatodes albogularis* are relatively well represented within populations. The SVL averages 35.5 mm (32-43) with the tail about 55% of the total length. The largest specimen is 43 mm SVL, and the smallest 18 mm SVL.

These geckoes constitute a large proportion of the faunal assemblage. They are active day and night, especially on overcast days. Unlike other geckoes, they are as likely to be encountered in open situations as in those with more concealed modifications, being occupants of high walls and vegetation.

Aristelliger cochranae - Two specimens of *Aristelliger* were collected from a large Mango tree on a grassy hill in central Ile à Vache, but are expected to occur elsewhere. These lizards are delicate-skinned, and were difficult to remove from the bark near the tree hollows.

Measurements are 51, and 60 mm SVL, with the tail approximately equal in length to the SVL (60 mm in smaller specimen). The meristic data leave one in a position of question as to the value of same. The larger specimen has such variability of scutellation that it is difficult, indeed, to place much emphasis upon that feature. By comparison, the smaller individual has quite regular scale formation. Furthermore, I have chosen to report data per-side (e.g., labials and digital lamellae).

Character	No. 12232	No. 12233
head length	15.0	12.4
head width	9.8	8.1
4th finger lamellae (each side)	11-11	10-16
4th to lamellae (each side)	18-?	13-10
supralabials	8-9	8-?
infralabials	8-?	7-7
head scales	21	15
loreals	16	13
dorsals	35	34
median postmentals	1	1

In the larger specimen, the scale configuration breaks up so utterly (i.e. labials, lamellae) as to be confusing. Furthermore, the subdigital lamellae should be regarded as "functional" whether divided or entire, rather than as considered by Schwartz & Crombie to include only those which are entire. Dentition is also regarded.

Anolis coelestinus - This common anole, widespread in the area, was collected in Les Cayes, Cavaillon, Ducis, St. Jean, Camp Perrin, Poste Avance, Dichiti and Ile à Vache. Elevationally they occur from sea level to 2,000 m in Massif de la Hotte. Low scrub, fences, and lower portions of trees are the most commonly frequented sites of occupancy.

Coloration and pattern designation in anoles is, in many ways, questionable, a factor somewhat apparent with regard to the present species. During daytime activity *A. coelestinus* individuals are generally vivid leaf green with a white stripe along the supralabials extending backward to the auricular opening. They may become gray or tan when disturbed (e.g. when being handled), rapidly changing through a speckled or reticulated gray phase. One moribund individual passed through color and pattern changes over unusually extended periods of time, so that the transitional hues were able to be observed. When it died it was a definite gray, marbled and reticulated with a darker gray, especially posteriorly.

Anolis cybotes - Anoles of this species were found at every locality. They inhabit many types of sites, but are most common on large trees in lowlands, and on rock outcrops in the high hills and Massif de la Hotte.

The dorsum is deep-tan with an olive blush, to dark brown, sometimes with dark crossbands. There are two pairs of subtle latitudinal lines, subtle lime in the center bordered on either side by burnt orange. Ventrally they are off-white, finely peppered with black. The dewlap is tan.

Anolis distichus - Collected at almost every locality, *Anolis distichus* appears to be somewhat more local in lowlands occurrence than is *A. cybotes*. Four specimens each of males and females respectively have SVL measurements of 47.0 (42-52) and 44.3 (43-47) mm. In life these appear dull olive to olive green dorsally, with a series of dark cephalic cross-bars, and a definite yellowish tail. Ventrally the color is off-white with the tail being burnt orange. The dewlap is lemon yellow with a deep magenta central spot.

Leiocephalus personatus - Populations of *Leiocephalus personatus* were sampled on Ile à Vache, near Laurent (E Les Cayes), and in Massif de la Hotte at Dichiti. Dense populations were encountered in Massif de la

Hotte.

These lizards are largely saxicolous, inhabiting boulders or cliff-faces. Individuals bask during sunny parts of the day.

All specimens collected or seen are females. The largest specimen is 90 mm SVL, varying from 67 to 90 mm as adults.

The head is tan dorsally; labials barred with tan and cream. There are two distinct dorsolateral stripes which vary in color from pale cream to bright yellow. Middorsally the color is mottled cream and tan, with usually 10 black crossbars. The sides are finely dotted with contrasting black and lemon-yellow. Ventrally the throat, forelimbs, chest, hindlimbs and tail are reticulated or flecked with black on light gray, yellowish or orange ground color. In the center of the belly is a large unmarked gray area.

There are 4 (sometimes 5) scales between the rostral and supraocular ring, lateral body keel (not a fold), dorsal heavily keeled, dorsal head scales heavily rugose longitudinally (as if bearing multiple folds); dorsals 47-55.

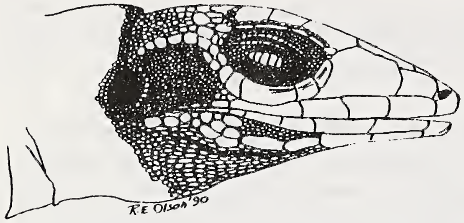
Ameiva taeniura - A common lizard in lowlands, populations were sampled at Les Cayes and 2 miles N Cavaillon. They were reported on Ile à Vache.

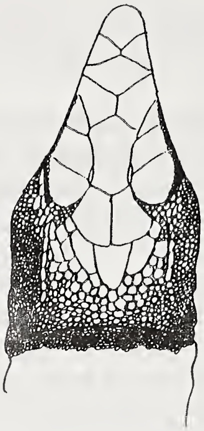
Mensural data for males are X = 67 mm SVL (67-71), for females 65.5 (60-69). These all bear the diagnostic 8 rows of ventral scales.

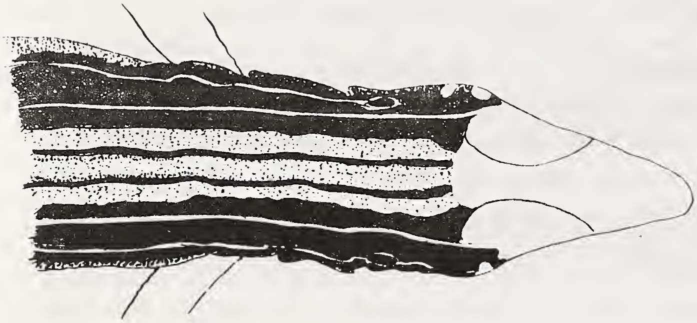
Dorsally the ground color is light olive along the midline, this because of three subdued longitudinal stripes to the the tail; these stripes join on the tail, continuing on that member as a median stripe of tan or greenish. Laterally on the body is a broad velvety-black band from the eye to the tip of the tail. This band is divided into two by a bright yellow stripe from the snout, along the body, and anteriorly on the tail. Another bright stripe borders the black field beneath from the ear or orbit to the tip of the tail. On the tail, all light stripes become greenish or somewhat bluish.

Ventrally the color is light greenish. The throat is entirely brilliant orange in males, less distinct in females, this color continuing onto the chest, where it fades.

Ameiva taeniura: – #12170, 2 mi. N Cavaillon, Dept. du Sud, Haiti.







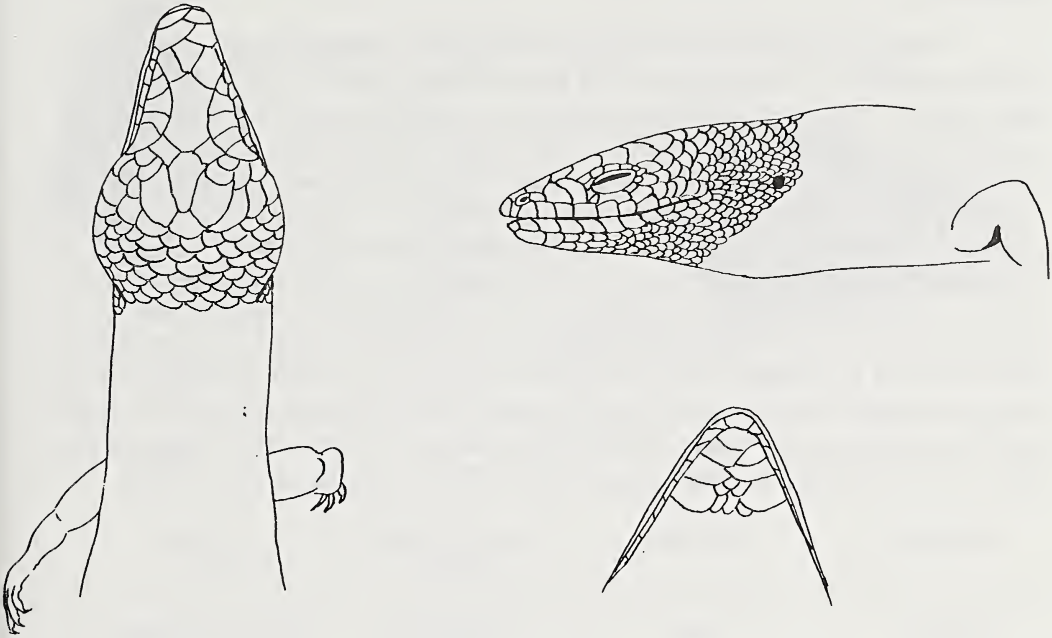
Celestus costatus - One of these lizards was collected in Massif de la Hotte near Dichiti. This species is rather like a robust skink. Dorsal scales are longitudinally gently grooved, and imbricate. Ventrals are plate-like, bearing modest pustules.

The legs, relatively short for the length of the body, and general structure betray fossorial habits.

The middorsum (12 scales wide) is bronzy brown with small black flecks throughout. Laterally, from the temporals to hindlimbs, a black band, interrupted by a vertical series of cream-colored spots which form lines. The ventral surface is an unmarked wash of lemon yellow, limbs variously mottled and reticulated with black.

The specimen is a male, 88 mm SVL, with 19-19 subdigital lamellae on the 4th toe, 1-1 loreals, 2-2 postoculars, and 10-10 supralabials.

Celestus costatus: – Massif de la Hotte, near Dichiti, Dept. de la Grande Anse, Haiti.



Epicrates striatus - Two specimens of this boa were collected, one, 2 miles N Camp Perrin, the other in Les Cayes. Total length of the largest approximates 1,800 mm, the smallest 900 mm. The irregular crossbars are deep tan on the smaller individual, whereas on the large the bars bear a distinct rose cast.

Habitat preference is usually scrub or forest lands, both in lowlands and hill country. The smaller specimen, however, was taken late one afternoon as it emerged from a burrow in loose sand 20 ft. from the edge of the Caribbean.

Antillopus parvifrons - This brown ground snake was collected in lowlands (Les Cayes, 2 miles E Les Cayes) and in Massif de la Hotte (2 miles S Dichiti).

One specimen is 367 mm (tail incomplete), with 8-8 supralabials, 10-11 infralabials, 1-1 preoculars, 2-2 postoculars, and 1-1 temporals. Color and pattern notes: deep brown dorsally, fading to gray on lower sides; supralabials white; deep brown stripe beginning at the snout, passing through the orbit, gradually broadens backwards past the temporals, narrowing as it continues rearward for a distance of about 80 mm. A cream-colored stripe begins over the orbit, extending rearward for the first 1/3 of the body, its being 2 scales broad, occupying the 4th & 5th scale rows a short distance from the neck, narrowing to one scale briefly, thence, rearward being indicated as an indefinite lightened area above a darker lateral area, from which it is sharply demarcated. The middorsum is deep brown, with a black vertebral stripe (beginning as a series of ill-defined spots on the neck) which runs the entire length of the body and tails. On the outer edges of the first 10-12 ventrals is a black spot. Ventrally the snake is dirty-white.

Specimen	ventrals	paravertebral stripes	ventral color
12252	152	subdued	blush of pink
12011	146	subdued	white
12182	135	bold	white

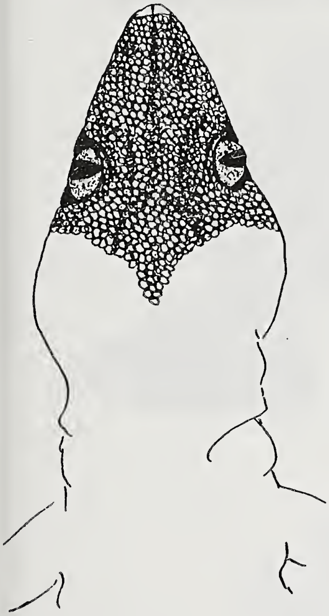
Uromacer catesbyi - Two specimens of green treesnake were taken, each at different localities: 2 miles E Les Cayes, and Ile à Vache (shed skin).

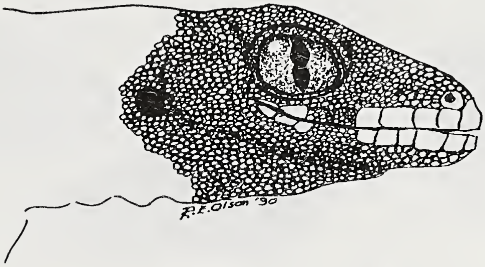
The snake is bright leaf-green middorsally, with two lower lateral rows of lighter green, distinct from the dorsal color. There is a broad black stripe from the tip of the snout, through the orbit, and back behind the head.

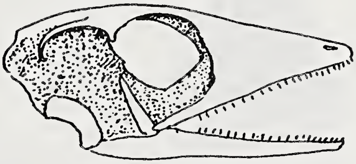
Eretmochelys imbricata - One Loggerhead Turtle was collected and brought in by a student from Baie de Cayes.

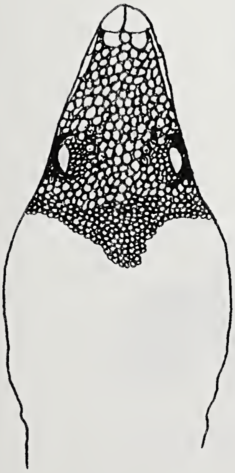
Chelonia mydas - An individual of the Green Sea Turtle was observed along the beach in Les Cayes, having been killed by fishermen.

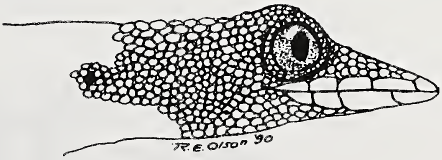
Upper: *Aristelliger cochranae*: – #12232, central Ile à Vache, Haiti.
Lower: *Sphaerodactylus copei*: – Les Cayes, Haiti.



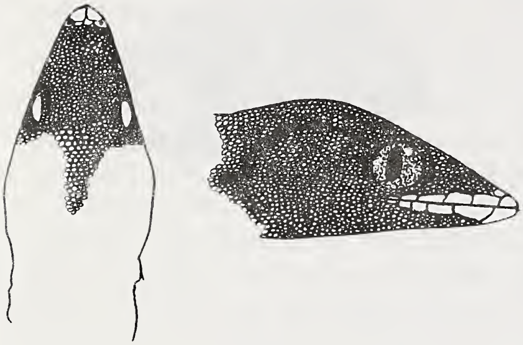


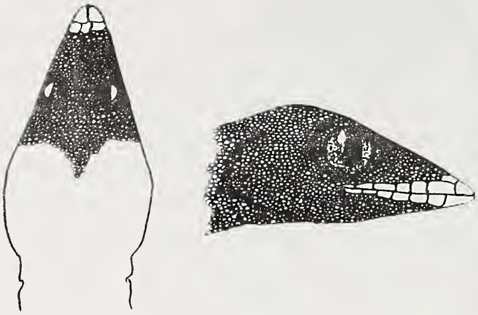


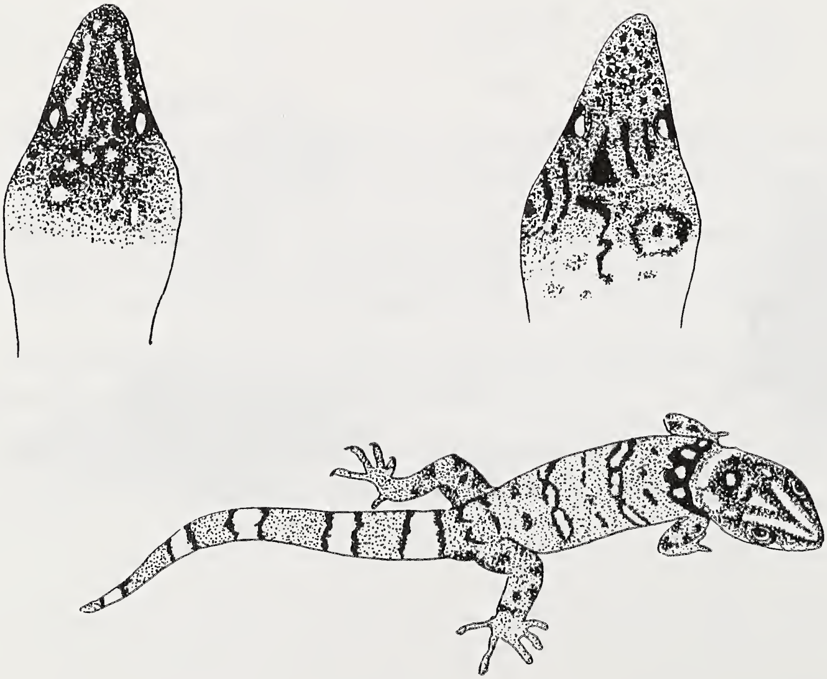




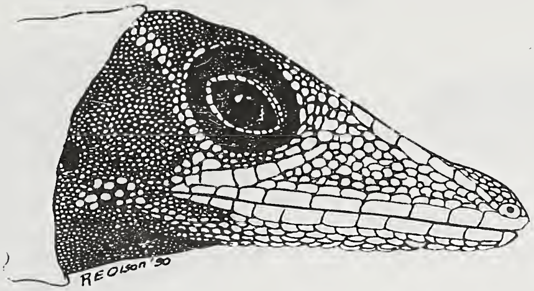
Upper left: – *Gonatodes albogularis*, #12667, Les Cayes, Haiti
Upper right: – *Sphaerodactylus cinereus*: –#11874, Les Cayes, Haiti.
Lower: – variation in dorsal head pattern in females of *Sphaerodactylus copei* from Les Cayes, Haiti.

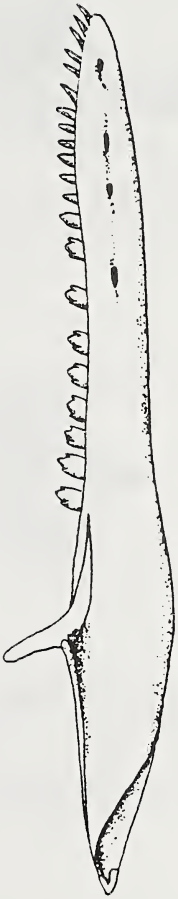


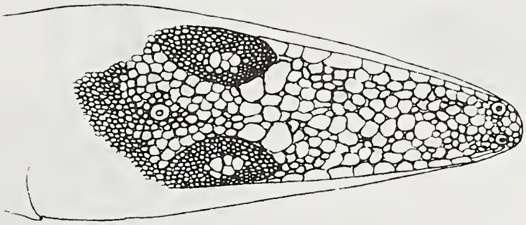


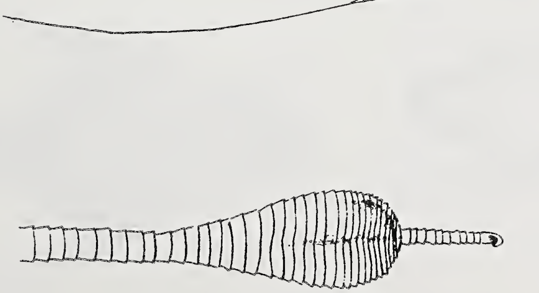


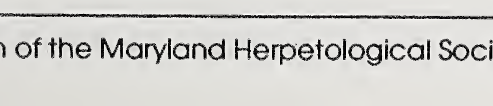
Anolis coelestinus - **skeletal #11785, entire specimen, #12231, Ile à Vache, Haiti**



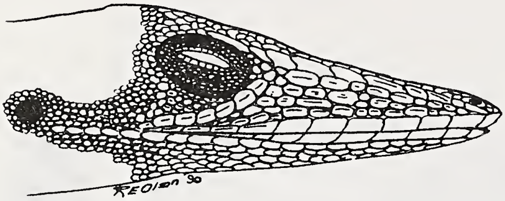


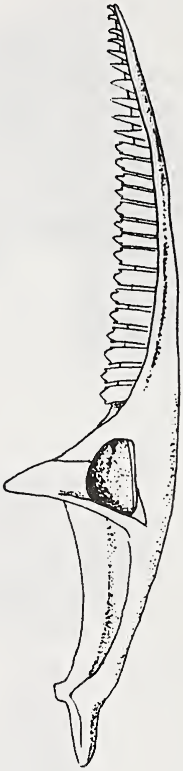


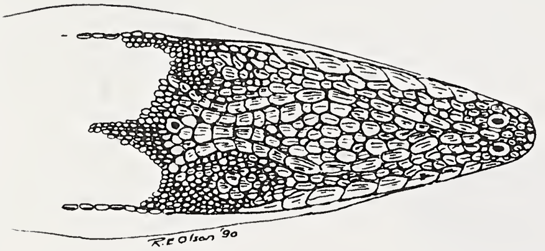


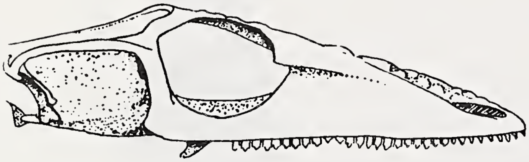


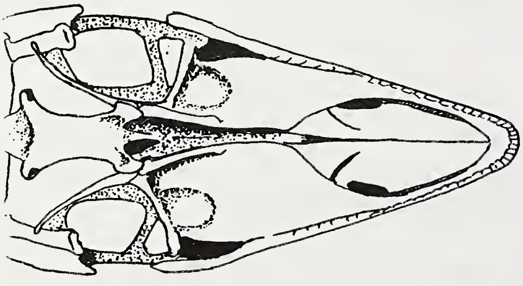
Anolis carolinensis: –#2040, for comparison with related *A. coelestinus*.







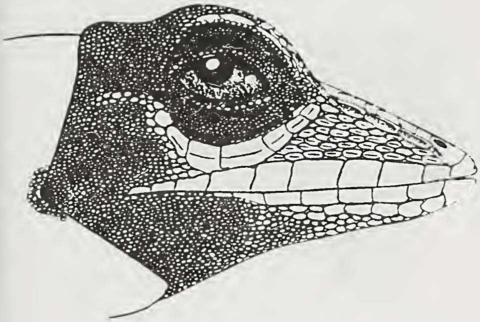


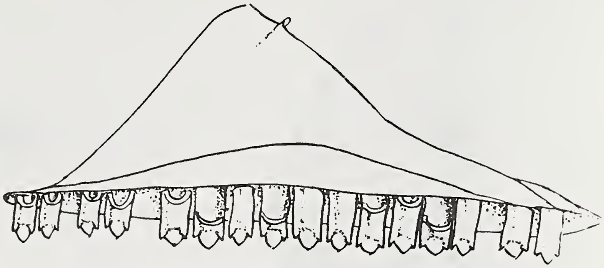


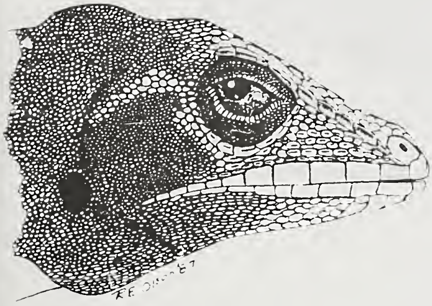
R E Olson '90

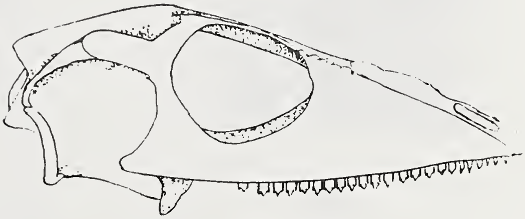
Upper: *Anolis distichus*: – skeletal #12142, entire specimen, #12224, central Ile à Vache, Haiti.

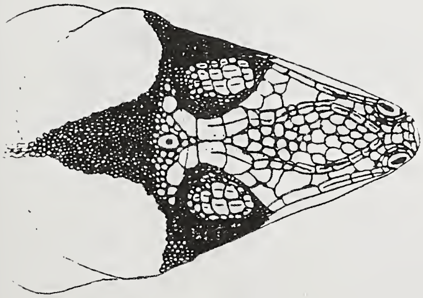
Lower: *Anolis cybotes*: – skeletal #12470, entire specimen, #12239, 3 mi. NW Camp Perrin, Dept. du Sud, Haiti.

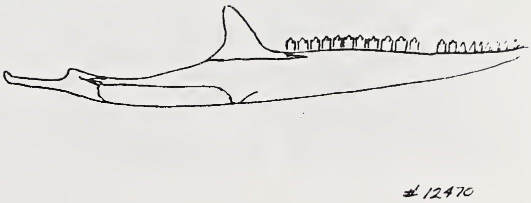




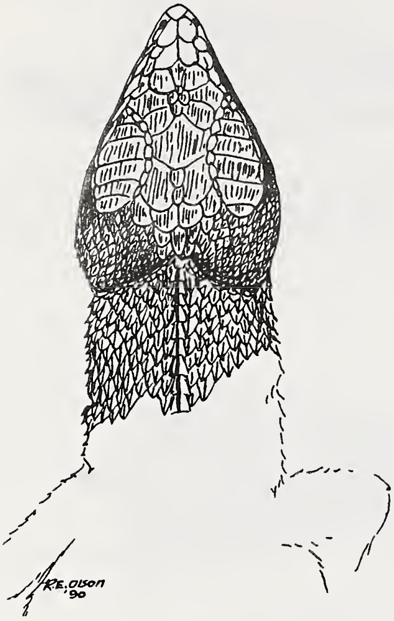


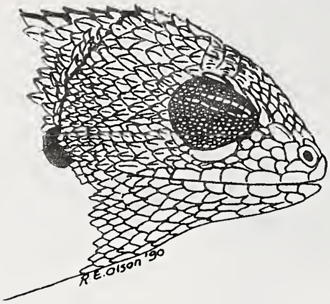


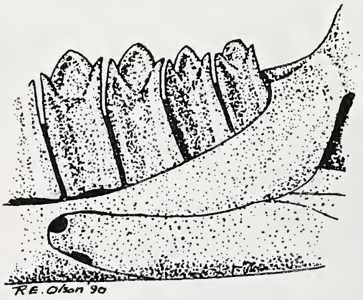


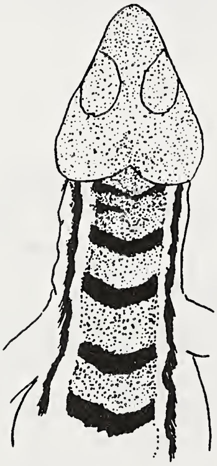


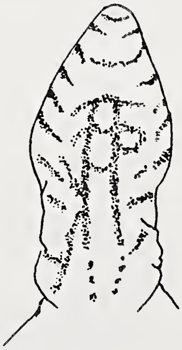
Leiocephalus personatus: – skeletal, #12196, entire specimen, #12206, Dichiti, Dept. de la Grand Anse, Haiti.



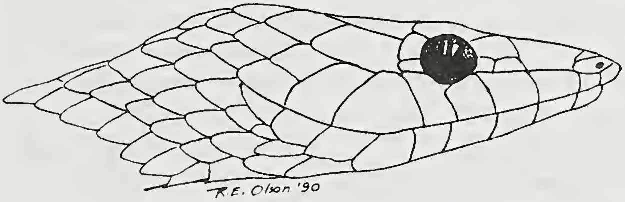


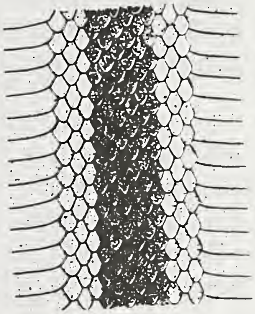


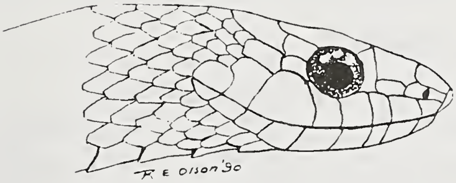


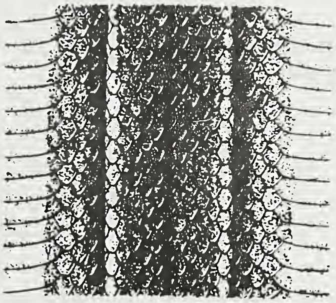


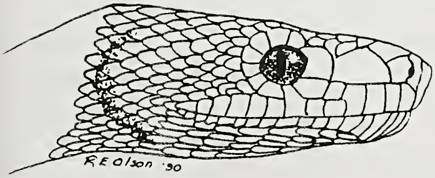
Upper: *Uromacer catesbyi*: – #12009, 2 mi. E Les Cayes, Haiti.
Middle: *Antillopus parvifrons*: – #12252, Les Cayes, Haiti.
Lower: *Epicrates striatus*: – 2 mi. N Camp Perrin, Dept. du Sud, Haiti; #11770.

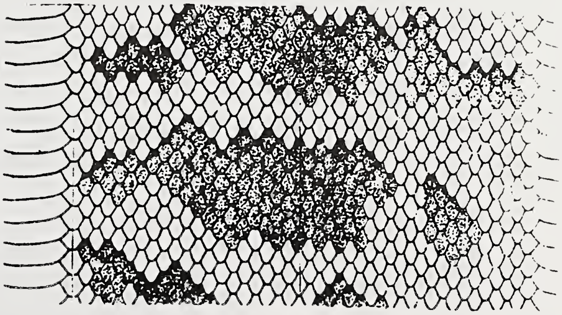












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I would like to thank many people who have helped in this effort. Professors Richard Homola and Richard Edgerton were not only very helpful in the field on many occasions, but also provided insights into the present project. Dr. Ronn Altig kindly identified tadpoles for me.

It would be a gross oversight not to acknowledge the many Haitians who, although humored by this herpetologist, were most always extremely courteous, and many times went out of their way in showing me sites or inviting me onto their property to collect specimens or to observe, and allowing me to set up camp. Transportation in the mountains would have been nearly impossible without assistance from many native Haitians.

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NOTES ON THE BIOLOGY AND STATUS OF A POPULATION OF *LEPIDOPHYMA TUXTLAE* (SAURIA: XANTUSIIDAE) IN THE SIERRA DE SANTA MARTA, VERACRUZ, MÉXICO

Jesús M. Castillo-Cerón and Carlos A. López González

Field work in a tropical rain forest from February to July, 1989, in Veracruz, Mexico, provided novel data on the natural history of *Lepidophyma tuxtlae*. Birth occurred in early summer. The diet of adults consists of 39.4% Coleoptera and 18.1% Hymenoptera. Habitat preference was observed, and it was discovered that this population is apparently almost all-female.

This species has received little attention from herpetologists. Its original description (Werler and Shannon 1957), part of its reproductive cycle (Greene 1970; Ramirez 1977) and its phylogenetic position (Bezy 1972, 1989; Bezy and Sites 1987; Savage 1963) have been noted.

Materials and Methods

The study area is located on the Sierra de Santa Marta between parallels 18°22'57" lat. N. and 19°55'50" long. W. at an elevation of 900 m (Figure 1). The weather is warm-humid with rain mainly during the summer with a dry season from December to May. Annual precipitation is 3750 mm, the mean annual temperature 23°C. Being a tropical rain forest (Miranda y Hernandez, 1963), it has an exuberant vegetation characterized by a complex biological community divided into 3 strata: one up to 5 m, the next ranging from 5 to 20 m and the last 30, often 45 m high. It has secondary growth composed of herb and shrub zones. These conditions give the forest floor the microclimatic conditions of litter, remaining in shadow and with constant temperature and humidity all day (Rzedowski 1978).

Collections were made on a four day trip each month, from February to July of 1989, in an area varying from 700 to 2300 h, hourly. For each specimen observed, the hour, microhabitat, activity, air temperature, substrate temperature, relative humidity, snout-vent length, tail length, mouth width, weight and sex were recorded.

The specimens collected were fixed in 10% formaldehyde and are deposited in the herpetological collection of the E.N.E.P. Iztacala, U.N.A.M. These specimens were used to establish their reproductive status and diet by analyzing gonads and stomach contents respectively.

Results

Thirty-seven specimens were observed and 12 collected: 10 females, one of unknown sex due to lack of preservation, and one adult male. The adult male (collected in February) had small testes (right, 4x2.1 mm, left, 3.9x1.9 mm, as compared with those reported in the literature; (Alvarez del Toro 1982, Greene 1970, Ramirez 1977) and no development of the circumvolutions of the epididis.

Egg development was evident in females in February, increasing to full sized embryos in late May and June. These data and field observations establish date of the birth as late June and July.

The clutch size varie from 3 to 5 with a mean of 4, with a significant correlation between clutch size and snout-vent length (r = 0.895).

The animals observed but not collected were all regarded as females based on the width of the abdomen and the base of the tail, indicating a ratio of 35 females to 1 male and implying an almost all-female population.

Composition of the diet was determined by analysis of stomach contents. The taxa and their percent (by volume occupied) is Coleoptera (39.4%), represented by the family Caroidae, Curculionidae and Tenebrionidae; and Hymenoptera (18.1%), represented wholly by the Formicidae. Miscellaneous organic matter, composed of both vegetable and animal material comprised 18.1%. Amphipoda constituted 12.6%, and Gastropoda 11.9%.

Most of the lizards (54.05%) were found beneath logs, 18.9% on buttresses, and 27.04% in other microhabitats (4 animals on trees, 2 on top of logs, 2 inside logs and 2 on litter). *L. tuxtlae* has been considered nocturnal, but all we observed were found active during the day.

Lepidophyma tuxtlae shares space and time resources with other species of lizards (pers. obser.) but considerable overlap is possible only between *Lepidophyma tuxtlae* and *L. pajapanensis.*

In the morning, animals were observed with half of the body out of their refuges, and when the sun began to shine directly on them, they would retreat into their crevices, turning around so that the tail was exposed. Several episodes of partial emergence occurred during the day.

One animal was observed in late afternoon leaving its den, seeking and eating prey, and then coming back about fifteen minutes later.

Discussion

Lepidophyma tuxtlae bears one clutch a year, like many other vivparous lizards. Eggs develop from December to June, and births occur in late June and July. The male collected in February showed no sexual activity, and may either have been sterile or, if fertile, representative of another, overlapping population (Bezy 1989). Females comprised 90.9% of the collected specimens that were sexed, and 97.2% of all 36 that were sexed.

Submitting our results to a contingency test (Simpson et al., 1960), we infer that this is an almost all-female population, in as much as there is no report of asynchronic use of resources by males and females (Telford and Campbell 1970). Populational isolation has been proposed as a very important factor in evolution of all-female populations (Bezy 1972), and may be pertinent to the present situation, in view of the limited distribution of the species.

A spontaneous origin has been suggested for the all-female populations of *L. flavimaculatum* (Bezy 1989), and the same may be true of L. tuxtlae, as suggested by the identical karyotypes and alloenzymes (Bezy and Sites 1986) in *L. flavimaculatum* and *L. tuxtlae*. Some selective advantage, such as improved colonizing ability (Bezy 1989) may be involved.

L. tuxtlae and *L. pajapanensis* are sympatric species utilizing the same temporal and spatial resources and probably dietary also; however, *L. tuxtlae* is the more abundant of the two species on Santa Marta, whereas at the Los Tuxtlas Biological Station *L. pajapanensis* is more common (Perez-Higareda et al 1987, Ramirez 1977). The difference may be due to a physiological adaptation for a cooler climate in *L. tuxtlae*, or the dispersion center of this species may be on the Sierra de Santa Marta.

Acknowledgments

This contribution forms part of a field biology program of the E.N.E.P. Iztacala U.N.A.M. (1989). The authors wish to thank T. Altamirano, A. González, E. Godinez and to anomymous reviewer for their guidance, advice and critical evaluation.

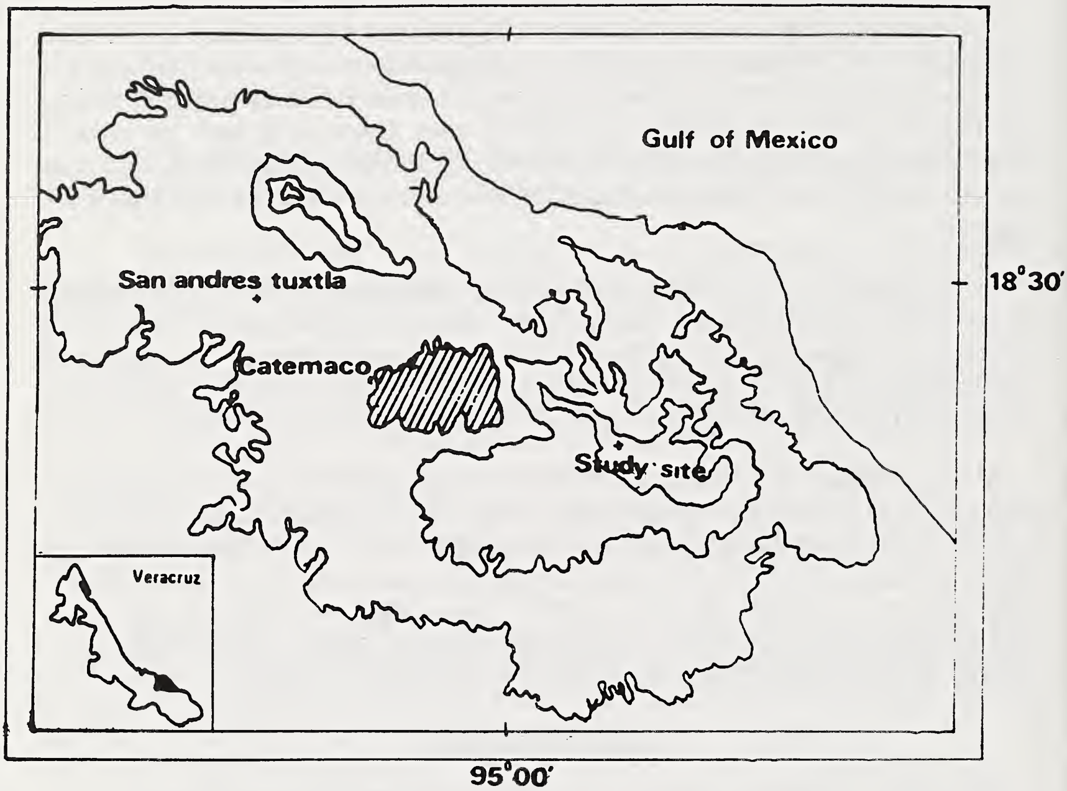

Fig. 1 Location of the study area in the Tuxtlas region, Veracruz.

▨ Lake

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OBSERVATIONS ON A *BARISIA RUDICOLLIS* WIEGMANN (SAURIA: ANGUIDAE) WITH NOTES ON ITS HABITAT

Alberto González-Romero and Carlos A. López-González

We report the first observations on the natural history of the "escorpion," *Barisia rudicollis*, an adult female caught at the Hacienda de la Gavia, State of Mexico, in 1978, and maintained in captivity for nineteen months. Observations were made mainly when the animal was fed.

Little is recorded about the natural history of Mexican anguids, especially about the "escorpion," *Barisia rudicollis*, described by Wiegmann in 1828 (Smith and Taylor 1950), based upon one female specimen collected by Deppe, with a snout-vent length of 121 mm, head 25 mm (Wiegmann 1834). The lectotype and two paralectotypes (erroneously termed holotype and cotypes, respectively) exist in the Berlin Museum (Taylor, 1969).

This species was one of the first six described for the group (Wiegmann 1828), known to science for 162 years. Although many collecting expeditions have been made either by Mexican or foreign researchers into or near the type locality, little success has resulted in obtaining more individuals of the species. Nothing is known about its habitat and habits (Tihen 1949), and even its color on life is not known (Good 1988). The meager literature on the species is based on few organisms, only two of recent capture (Casas-Andreu, pers. comm.): the one reported by Martín del Campo (1939), and the present specimen. Both animals are from Hacienda de la Gavia, and are in the herpetological collection of the Instituto de Biología, U.N.A.M., ours with catalog number 02701.

Description of the collecting area

Hacienda de la Gavia is located at 19°24' N, 99°53' W, in the foothills of the mountains of La Gavia at an altitude of 2550 m (Fig. 1). The area belongs to the Neovolcanic axis, bordering on the Nevado de Toluca in a SE-NW direction, to the west limited by the Valley of Toluca, to the north joining the Sierra of Tlalpujahua. The main peaks are Cerro Acatitlan, El Calvario, Atequelite, Pedregal, Tilaxto and Cerro Valiente (Porrua, 1986).

The climate is temperate, with a mean annual temperature of 12.9°C and a precipitation of 921 mm (Garcia, 1973), mostly in summer. The area was originally covered by a dense forest, mainly of Pine (*Pinus* spp.), Pine-

Oak (*Pinus-Quercus*) and fir (*Abies religiosa*). Large Montezuma Bald Cypress (ahuehuetes) (*Taxodium mucronatum*) and weeping willow (*Salix* sp.) occur near streams. At one time the hacienda covered an area of thousands of hectares, east onto the slopes of the Nevado the Toluca, to the boundaries of the states of Mexico and Michoacán, to the present Bosencheve National Park, and south to the state of Guerrero.

Intense agricultural and ranching activities over the past 200 years mainly corn planting, lumbering and more recently, sheep grazing, deforested almost 90 per cent of the area. Today the hacienda embraces only 30 ha but is one of the few preserved forested areas. In the rest of the zone, the forest persists only in scattered glens of various sizes. All of these changes, combined with the common belief that these lizards are poisonous (Cuesta-Terrón, 1930); González-Romero and López-González 1989; Good, 1988),and therefore are to be killed, have made *B. rudicollis* one of the rarest of all Mexican lizards, without doubt in imminent danger of extinction.

On five field trips after the capture of this specimen, no other has been found, even when Hacienda de la Gavia was visited. The other surveys were made to Valle de Bravo, Bosencheve, San Cayetano and the slopes of the Nevado de Toluca, all in the state of Mexico surrounding the type locality. Except at Valle de Bravo we often found specimens of *Barisia imbricata imbricata*, a species related to *Barisia rudicollis* (Good, 1988; Tihen, 1949).

Specimen description

The animal is an adult female, taken October 19, 1978, and preserved May 10, 1980. It died from a massive infestation of Mites (Trombiculidae). The ground color of the animal (Fig. 2) was reddish-brown with irregular (lichen-like) gray spots on the dorsum; on the sides these spots became dark vertical bands extending from the armpit and ending at the groin. The bands were two scales wide and with the posterior edge darker. A diagonal black line extended from the anterior edge of the orbit toward the eighth supralabial scale. The belly was light brown with irregular dark suffusions. The tail was prehensile, and the legs relatively long compared with those in *Abronia*, a genus of arboreal species (measurements in Table 1).

Activity-shedding

During the nineteen-month period that the lizard remained alive the animal shed its skin three times. The first was on the sixth month of captivity (November 28, 1978), and the second six months later (May 30, 1979) and the last on April 29, 1980. Shedding was complete each time, in one piece, as in other gerrhonotine lizards.

Like *Gerrhonotus*, *Elgaria*, *Abronia* and other species of *Barisia*, the shedding process began at the mouth. The process always took place after a huge meal, and was completed in about 35 minutes. First, the animal rubbed its lips against a stick with lateral movements, freeing the snout tip, and then slipped the skin over the head with side to side, forward movements. This stage required about 10 minutes.

When the mouth was thus started, the animal slid between the sticks and loose bark in the terrarium until the skin caught on some object, after which the lizard, with snake-like movements and deep breathing , sliding very slowly forward at the same time, pulled the old skin from the body. When the back legs were free, the animal began to walk until the skin stuck on a branch and then the skin was pulled free from the tail.

When the process was over, the animal walked for a few minutes around the terrarium, and then hid under a piece of bark, not coming out again until the next day.

Activity-movements

Usually our animal showed little activity, compared with other specimens of the same genus (e.g. *Barisia i. imbricata* and *B. i. ciliaris*) except on the days when it fed or shed. The greatest activity occurred during the mornings, when the temperature was 20-24°C, or during afternoons when the temperature was the same.

Most of the time was spent perched on branches. During peaks of activity it came down to walk around the terrarium, then perching on a branch 2.5 cm in diameter, which always seemed to be preferred.

Wiegmann (1834) reported that *Barisia rudicollis* was captured among rocks, but Tihen (1949) suggested that it has arboreal habits. That suggestion is in accord with our observations; in addition to the preference exhibited for the branches in the terrarium, many times when the animal was released in an enclosed garden, it immediately sought trees or bushes, climbing them readily and using its prehensile tail which, as in *Abronia*, could curl around a supportive branch. (Fig. 2).

When the lizard felt safe, its movements became slower and more deliberate until it found a comfortable place on a branch, where it could remain for hours in the same position. It never tried to run away like other species of the family, and did not attempt to bite the hand that was grasping it. Generally it was a "tame" animal.

Activity-feeding

During its nineteen-month period of captivity, our lizard was fed various invertebrates collected with a net. They were always taken in Pine-oak and Pine-alder forests, near Mexico city, in an attempt to offer the lizard food as familiar to it as possible. The prey captured were mainly several species of grasshoppers (Acriididae), spiders (Araneae), and beetles (mainly those of the family Melolonthidae). When all three were present in the terrarium, the lizard ate first the beetles, later the spiders and last the grasshoppers. The choice seemed to be determined not by kind of prey but by movement, the beetles being the slowest and first attracting the attention of the lizard. The spiders initially moved very fast, but later established themselves in a corner, where they became fixed targets. The perpetually mobile grasshoppers were eaten last, but provided food for several days.

At least once a month a medium-sized mezquite lizard (*Sceloporus grammicus*) or bunch grass lizard (*S. aeneus*) were offered, and invariably they were consumed sooner or later. Of the two species, *S. grammicus* was captured in less time because, probably, it shared the habitat of *B. rudicollis* on the branches in the terrarium whereas *S. aeneus* never climbed, and had to be captured on the ground, where the *Barisia* spend less time. These two iguanids are abundant in the vicinity of Hacienda de la Gavia (personal observations).

In catching prey the alligator lizard utilized a technique similar to that of other gerrhonotines. First, movements of the prey alerted the lizard; second, it rushed to within about 5 cm of the prey without being noticed; third, its movements then were very slow and difficult to discern, maneuvering for a face to face confrontation with the prey; fourth, being only about 2 cm from the prey, and its hind legs gathered to spring, the lizard launched itself at the prey. It rarely missed, being more efficient than other species of *Barisia* in captivity (personal observations).

Discussion

Tihen (1949) regarded *B. rudicollis* as "an early, but in some respects highly specialized, derivative of the ancestral stock of this group", probably intermediate between the terrestrial *Barisia* and completely arboreal *Abronia*. This might or might not be true, but north of La Gavia we found *B. imbricata* (terrestrial) and to the south on lower lands at Valle de Bravo *Abronia deppei* (arboreal) occurs (Sanchez-Herrera and Lopez-Forment 1980), all within a distance of 37 km. Thus in both an ecological and ethological sense *B. rudicollis* seems to be an intermediate form.

The present observations reinforce the idea that *Barisia rudicollis* spends a good part of its life in trees, and the rest on the ground probably moving from one tree to another, because our animal was caught between trees (*Pinus* spp.) in a bunch of grass and the one reported by Wiegmann (1834) was near trees (*Quercus* sp.) among rocks. Moreover, because it is a form with a lot of primitive characters (Tihen 1949) and continues living near the dispersion center of the genus, it might be expected to occupy a more generalized habitat than its more derived congeners. However the habits and habitat of this lizard won't be confirmed until more observations are made in its natural environment. Smith et al. (1983) noted that Wiegmann reported viviparity in *B. rudicollis*, recording in the female holotype five embryos, two completely developed and all in all ways similar to the adult. We assume that the two "cotypes" mentioned by Taylor (1969) are from the five embryos Wiegmann described, and that this species is viviparous as are all other species of *Barisia* (Guillette and Casas-Andreu, 1987; Karges and Wright, 1987). Wiegmann's (1828) report of viviparity is the earliest for any species of *Barisia*.

Conclusions

We regard this species as intermediate between *Barisia* and *Abronia*, although a member of the former genus. Its limited geographic distribution, scarcity and proximity with *Barisia imbricata* and *Abronia deppei* make *Barisia rudicollis* doubly of interest for further research, being intermediate ecogeographically as well as morphologically between more primitive and more derived species of the Gerrhonotinae. Further research is urgent to define the status of the population, its geographic and ecological distribution, because its habitat is rapidly vanishing.

Acknowledgments

We are especially grateful to Jorge Santa María, who realized how uncommon and valuable the lizard was, rescuing and giving it to us; to Gustavo Casas-Andreu and Aurelio Ramirez-Bautista for their counsel, and to an anonymous reviewer who improved the manuscript.

Table 1. Measurements of two specimens of *Barisia rudicollis* from Hacienda de la Gavia, MPIO. of Villa Victoria, State of Mexico, Mexico. (Inc) = tail incomplete. All measures in mm.

Measurements	Male (1939)*	Female (1980)
Snout-vent length	105.0	120.0 (125)
Tail length	108.0 (Inc)	136.0 (140)
Head length	25.4	30.0
Head width	18.5	20.0
Head depth	14.2	15.0
Fore leg length	28.0	32.0 (34)
Hind leg length	34.0	41.0
Distance between legs	51.0	70.0
Fourth finger	8.3	—
Fourth toe	11.4	—

*Measurements taken by Tihen (1949) of the animal referred to by Martin del Campo (1939).

The measures in parenthesis were taken a year and seven months after the others.

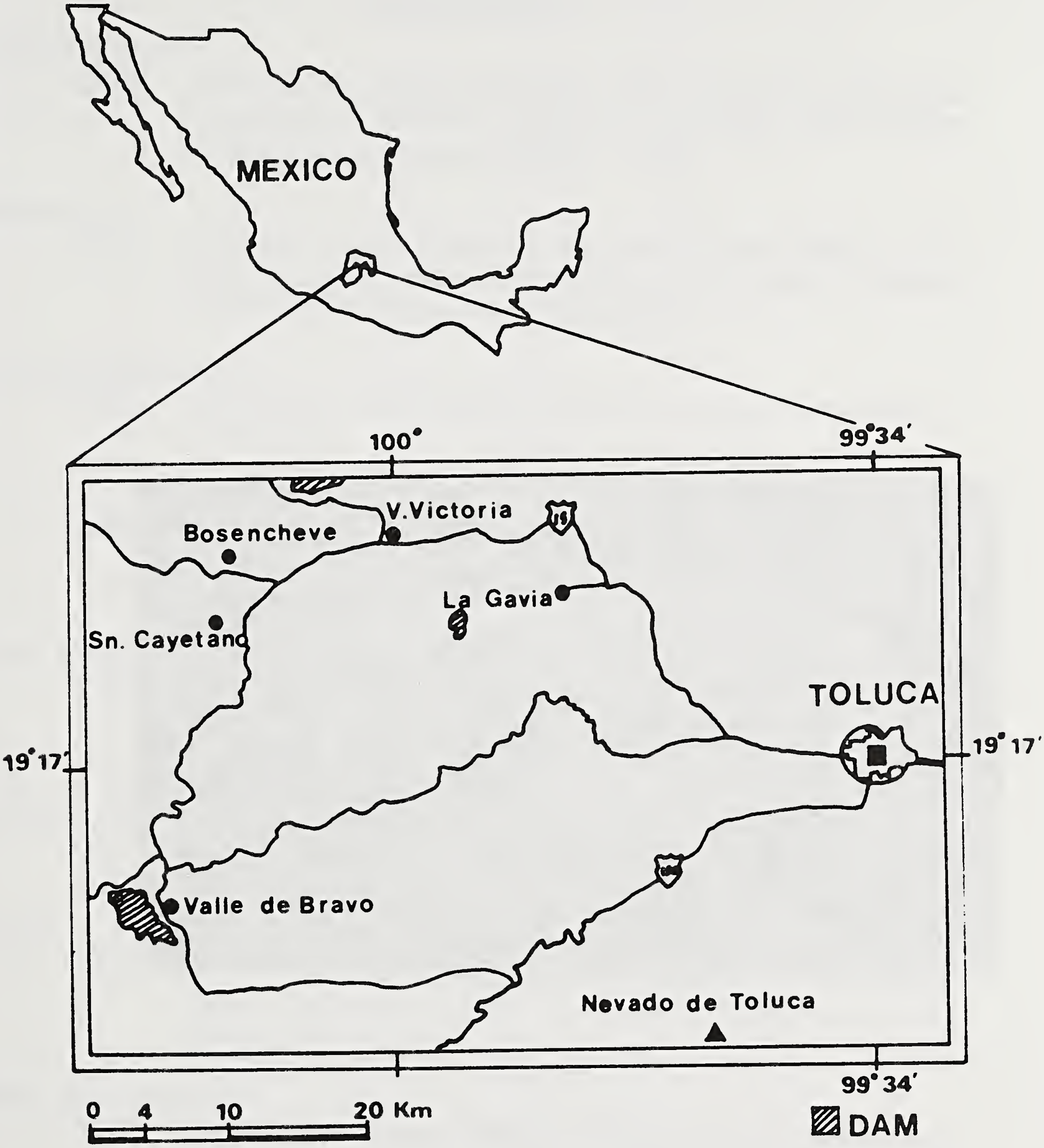

Fig. 1. Geographic location of Hacienda de la Gavia and the other localities searched for *Barisia rudicollis* in the state of Mexico.

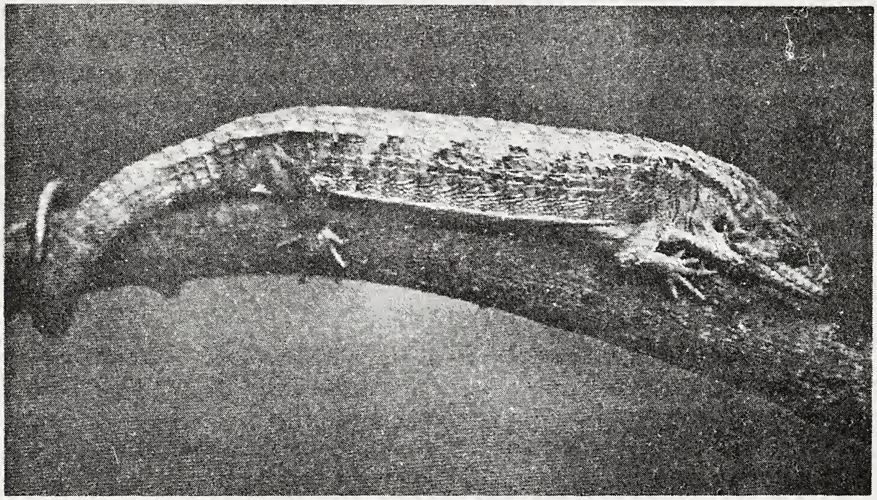

Fig. 2 Photograph of the *Barisia rudicollis* here reported, showing the main features of the species. Note the functional prehensile tail.

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CORAL SNAKES (*SERPENTES, ELAPIDAE*) FROM HYDROELECTRIC POWER PLANT OF SAMUEL, RONDONIA, BRAZIL, WITH DESCRIPTION OF A NEW SPECIES

Janis A. Roze and Nelson Jorge da Silva

A new species of coral snake, *Micrurus rondonianus* is described from Rondônia, Brazil, related to *M. hemprichii*, from which it differs in not having any triad pattern dorsally.

A key distinguishes the species of coral snakes known from Rondônia: *M. rondonianus*, *M. surinamensis surinamensis*, *M. spixii spixii*, *M. paraensis*, *M. lemniscatus helleri* and *M. albicinctus*.

Resumen

Se describe una nueva especie de serpiente coral, Micrurus rondonianus procedente de Rondônia, Brasil, relacionada con M. hemprichii de la cual se distingue por la ausencia de triadas dorsales.

Se ofrece una clave para distinguir las especies de corales de Rondônia: *M. rondonianus*, *M. surinamensis surinamensis*, *M. spixii spixii*, *M. paraensis*, *M. lemniscatus helleri* y *M. albicinctus*.

During a rescue operation at the Usina Hidroeletrica Samuel (Hydroelectric Power plant of Samuel) in the state of Rondônia, Brazil, about 16,000 animals were saved from the areas being inundated by the project. Among them were about 3,500 reptiles and 2,000 amphibians, including several species of coral snakes, one of which turned out to be undescribed.

The Hydroelectric Power Plant of Samuel is situated 87 meters above sea level on what was earlier know as Cachoeira de Samuel (Samuel's Waterfall) on Rio Jamari, an affluent of Rio Madeira. It is about 52 km form Porto Velho, the capital of the state of Rondônia. Samuel's reservoir, when completely filled, will cover an area of 560 sq. km.

Th inundated area consists essentially of tropical rain forest. About 20,865 hectares of the project's land were designated as an Area of Protected Environment (Area de Protecão Ambiental), where many of the rescued animals were released. This area will remain permanently protected and will serve for the study of the local flora and fauna by national and foreign ecologists and biologists. This is particularly important because much of the

Rondônia currently is undergoing a rapid expansion of agricultural and gold mining activities with accelerated loss of primary tropical rain forest.

The rescue operation, called Operacão Jamari, sponsored by Eletronorte, the state enterprise in charge of developing hydroelectric power in Brazil, lasted from 14th of November, 1988 to 23rd of March, 1989. The rescue team from the Centro de Estudos e Pesquisas Biológicas of the Universidade Católica de Goiás took part in the operation from 19th to 25th of November, 1988 and from 20th of December, 1988 to 5th of March, 1989 and collected the snakes that are subject of this publication.

The snakes, mentioned in the present publication, are deposited in the following museums and institutions:

AMNH	-	American Museum of Natural History, New York.
IMTM	-	Instituto de Medicina Tropical, Manaus, Brazil.
MCZ	-	Museum of Comparative Zoology, Harvard University.
MPEG	-	Museu Paraense "Emilio Goeldi", Belém, Para, Brazil.
UCG	-	Centro de Estudos e Pesquisas Biologicas, Universidade Católica de Goiás, Goiânia, Goiás, Brazil.
USNM	-	National Museum of Natural History, Washington.

Micrurus rondonianus new species

(Fig. 1)

Holotype: UCG 3299, a male from the Hydroelectric Power Plant of Samuel (Usina Hidroeletrica Samuel), Rondonia, Brazil, 85 m above sea level, collected by Nelson Jorge da Silva and the animal rescue team of the Universidade Católica Goiás, Brazil, between December 1988 and March 1989.

Paratypes: All paratypes come from the same locality, collected by the same team and during the same time period as the holotype. Males: UCG 2800, 2858, 2910, 2911, 3019, 3020, 3021, 3023, 3025, 3098, 3100, 3132, 3142, 3144, 3145, 3146, 3203, 3264, 3298, IMTM 739 and 740, AMNH 136299, MCZ 175905, USNM 304362. Females: UCG 2857, 2860, 2861, 3022, 3024, 3099, 3143, 3641, 3642; IMTM 741, 742 and 845; MPEG 18025.

Diagnosis: The new species is related to *Micrurus hemprichii* in having a single anal shield and brownish sepia bands, but differs in absence or near absence of black triads dorsally. The body is black with only brownish sepia bands, but triads are irregularly marked ventrally, by two white spots on each black band between the brownish sepia bands. There are 5 to 7 complete triads, distinguishable ventrally; 173-183 (mean 176.2) ventrals in males and 174-183 (180.2) in females; 26-32 (27.9) subcaudals in males and 22-28 (15.1) in females.

Description of holotype: The number and distribution of cephalic shields and other characteristics are typical of the genus *Micrurus*. Rostral wider than high, visible from above; internasals wider than long, but shorter than prefrontals. The latter about as long as their distance from the snout. Frontal longer than wide, approximately as long as its distance from snout. Supraoculars about as long as prefrontals, and parietals about as long as their distance from the posterior suture of internasals. Nasal divided; prenasals larger than postnasals, in contact with the first two supralabials. Preoculars longer than high; two postoculars, the upper slightly larger than the lower; 1+1 temporals; 7 (3,4) supralabials and 7 infralabials, first four in contact with anterior pair of genials; fourth infralabial the largest, in contact with both pairs of genials. Anterior pair of genials shorter than the posterior.

The holotype has 173 ventrals, a single anal, and 24 divided subcaudals; 15-15 dorsals. The total length of the holotype is 633 mm, 52 mm of which comprise the tail length, giving the tail length/total length ration of 0.0894.

Snout black including the frontal and anterior part of the parietals, followed by a brownish sepia band that covers the first dorsals. The borders of the parietals, the temporals and the first dorsals are black. Below, the head is all white including the first three scales behind the tips of the genials. Body covered by large black bands, 27 to 32 dorsals long. They are separated by sepia bands about 2 to 3 dorsals and 5 to 6 ventrals long. Ventrally, between the sepia bands are 2 white spots, 3 to 4 ventrals long, that are reduced in size ventrolaterally, but extend onto the first dorsals. The ventral coloration is suggestive of black triads, distinguishable only ventrally and separated by the brownish sepia bands.

The holotype has 5 2/3 black triads, distinguishable ventrally, and 1/3 plus a large black band on the tail, separated by a large sepia band about 5 dorsals long.

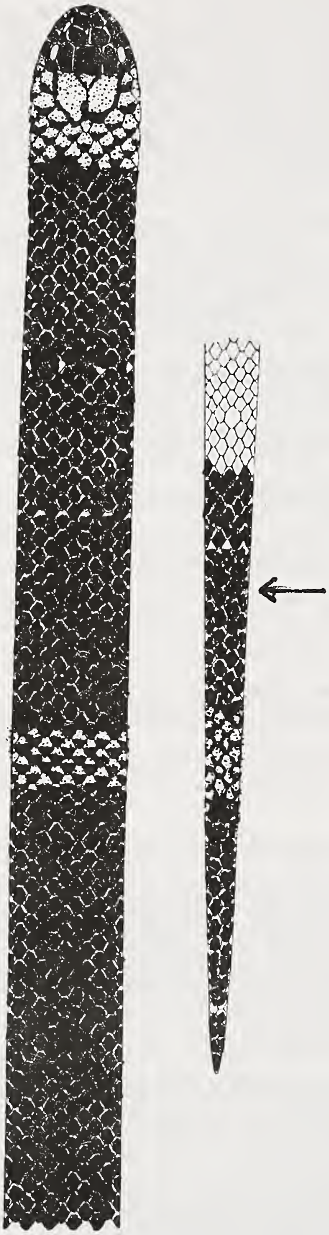

Figure 1. Color pattern of AM 136299 paratype of *Micrurus rondonianus* new species.

The holotype has both hemipenes fully everted. It is about 6 to 7 subcaudals long, bilobed with a bifurcated *sulcus spermaticus*. The base of the organ is covered by tiny spinules, irregularly distributed over the entire surface; an almost naked fold present on the dorsal surface of the organ. The border of the fold sharply outlines the upper part of the organ that is covered with large spines of uniform size. The spines continue on the lobes but are somewhat smaller. The *sulcus* bifurcates at the level shortly before the organ becomes bilobed and ends near the apex of each lobe.

Description of paratypes: Head shields and coloration is similar to the holotype. The paratypes, 22 males and 13 females, invariably with 7 supralabials and infralabials, 1+2 oculars, and except one, 1+1 temporals. One specimen, (UCG 3144) with 1+2 temporals. The anal entire in all specimens. The ventrals vary from 173 to 183 (mean 176.2) in males and from 174 to 183 (180.2) in females; subcaudals, from 24 to 32 (27.9) in males and from 22 to 28 (25.1) in females.

The snout is black, including the first 4 supralabials and it includes or not the tip of the frontal. The first black dorsal band reaches the tips of the parietals, or stays up to 4 dorsals behind them. Parietals, both temporals and first dorsals have a black posterior border. The head below is all white, except the mental which is usually black. In some specimens, the posterior border of the first pair of infralabials is black. The body is covered by brownish sepia, occasionally slightly orange bands, 5 to 7, occasionally 8 ventrals long, but reduced laterally and dorsally, where they cover two or three dorsals. The white bands are reduced to an irregular white ventral spot one to 3 ventrals long, sometimes only barely indicated by a group of small white spots laterally. In some paratypes the white ventral spots extend over the dorsum as a string of whitish spots around the body that form a complete band (ring), as if forming a complete white band of a triad. On the tail is at least one brownish sepia band, but the anal plate in 28 specimens is situated before it, and in 9 specimens approximately within or slightly behind the brownish band.

Counting the complete triads, distinguishable ventrally, the males have 5 to 7 black triads (or 5 to 7 long black bands on the dorsum, separated by yellowish sepia bands) and females also have 5 to 7 black triads, distributed in the following way:

	Number of triads						
	5	5 2/3	6	6 2/3	7	7 2/3	mean
males (n=23)	—	7	—	10	3	2	6.43
females (n=13)	2	6	2	2	2	—	5.91

Notes: The number of ventrals and subcaudals of the new species display a somewhat weakly expressed sexual dimorphism, typical of coral snakes. While the range is clearly overlapping, the means show males with more numerous subcaudals (mean 27.9 vs. 25.1) and less numerous ventrals (mean 176.2 vs. 180.2) than females. This reflects, apparently, the longer tail of males that provides space for the hemipenis.

On the other hand, the total ventral shields (ventrals plus subcaudals) of males and females, including the holotype, do not display the sexual dimorphism, found in ventrals and subcaudals separately. Males have 197-211 (204.1) and females have 196-209 (205.3) total ventrals.

The new species is apparently related to *Micrurus hemprichii* and it is possible that it is subspecifically related to it. Vanzolini (1986) mentioned *M. hemprichii* for Rondônia, but had no specimens collected during his herpetological survey of the Highway BR-364 region in Rondônia. His record probably refers to the new species, described here. Nascimento *et al.* (1988), covering the same general region of Highway BR-364 in Mato Grosso and Rondônia, did not find any specimens of *M. hemprichii.*

Notes on other coral snakes

At least six species of coral snakes have been recorded from Rondonia; four of them, *M. spixii spixii*, *M. albicinctus*, *M. lemniscatus helleri*, and *M. rondonianus*, were collected during the rescue operation at the Hydroelectric Power Plant of Samuel. In addition, Nascimento *et al.* (1988) reported *M. paraensis*, which constitutes a surprising extension of distribution of this northeastern Amazon species, described from Pará, Brazil. Vanzolini (1986) reported *M. surinamensis* (*surinamensis*) that was not found in Samuel, presumably because the snake is semiaquatic or aquatic and could easily escape from the floods. He also reported the presence of *M. mipartitus* in Rondônia, a doubtful record as this species is known from the Andes of Peru, northward. It is possible that Vanzolini confused this species with *M. albicinctus*, a similar species with a high number of only black and white body bands. The latter species was synonymized with *M. ornatissimus* by Cunha and Nascimento (1982), but it is obviously a good species (Roze, 1983), represented by a dozen or so specimens in the Samuel collection.

Key to coral snakes (Micrurus) reported in Rondonia

1. Anal plate single; black and yellowish dorsal bands .... *M. rondonianus*

–. Anal plate divided; not black and yellowish dorsals 2

2. Only one supralabial in contact with orbit: supraocular wider than frontal ....*M. surinamensis surinamensis*

–. Two supralabials in contact with orbit; supraocular narrower than frontal 3

3. Black bands in triads (sets of three) 4

–. Black bands single, alternating with red or white bands 5

4. The first triad complete (consisting of 3 black band); snout with regular black, red and white crossbands ....*M. lemniscatus helleri*

–. First triad consisting of 2 black bands; head all black, sides spotted with black and light spots ....*M. spixii spixii*

5. Less than 20 black body bands; red bands melanistic ...*M. paraensis*

–. More than 60 black body bands, alternating with single white bands *M. albicinctus*

Acknowledgments

We thank to Paulo Bürnheim, Franscisco Paiva do Nascimento, Amanda Bernal Carlo, and the members of the animal rescue team of Universidade Católica de Goiás, as well as Aníbal Melgarejo and Hobart M.

Smith for help in various contexts.

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BOOK REVIEW

Tyning, Thomas F. 1990. *A Guide to Amphibians and Reptiles.*

Little, Brown and Company, Boston, Toronto, London. xiv + 400 p.

The latest in the Stokes Nature Guides series, this volume will interest both the neophyte beginning to observe herpetofauna, the experienced amateur naturalist, and the professional herpetologist. Mr. Tyning is a Master Naturalist on the staff of the Massachusetts Audubon Society. Eight selected common frogs, six salamanders, six turtles, four lizards, the American alligator, and seven snakes, all from the continental United States, have life histories presented in a very engaging, enjoyable fashion. Illustrations by Andrew Finch Magee, and range maps by Tyning and Timothy J. Flanagan, accompany each species. With the exception of the Regal Horned Lizard, *Phrynosoma solare*, and the Gila Monster, *Heloderma suspectum* all species are from eastern or southern United States, with many extending their ranges westward and northward.

A Quick Reference Chart, giving pertinent aspects of size, eggs, hatchings, and other reproductive data, ends each account. The illustrations are very well done, and are alone worth the price of the book ($11.95 in the U.S., $14.95 in Canada). A full page illustration introduces each species, and others are within the accounts. Some unique illustrations are a snapping turtle hatchling with the egg tooth, a garter snake shedding its skin (ecdysis), and a hatchling alligator basking on the mother's head.

The author begins each account by recalling some nostalgic observation about the species, and continues to give other things on habitat, and other associated organisms. Each account is then divided into two headings: How To Recognize ____________ , and What You Can Observe. Subheadings under the latter include spring activity, territorial behavior, courtship and mating, breeding, food and feeding, tail function, overwintering, and other interesting topics.

The use of binoculars to observe behavior is recommended in many accounts. The emphasis is upon observation of life history, behavior, and conservation.

Twenty-four pages of Selected References, with subheadings for each of the thirty-two species, add value for the person wanting to review any species in greater detail. It is unusual to have this large a bibliography in a book of this type. The only criticism is that for seven species, a subspecies common name is the title below the range maps, yet the range of the entire species is shaded.

Having had only Ditmars' books, and Schmidt and Davis in my youth, a book of this type would have been quite welcome.

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BOOK REVIEW

Oklahoma Herpetology: An Annotated Bibliography by C. Carpenter and J. Krupa. 1989. Oklahoma Mus. Natur. Hist. Univ. Oklahoma. Norman VII +258 pp. $21.95.

In 1970, Robert G. Webb published *Reptiles of Oklahoma* which contained keys, checklists, dot maps and a complete bibliography. During 1989, Stephen M. Secor and Charles C. Carpenter published *Distribution Maps of Oklahoma Reptiles* which contained a checklist with updated names, county maps and an updated partial bibliography. The later work contained many references from the "Bulletin of the Oklahoma Herpetological Society" which began publication in 1976. To these works Charles Carpenters' and James Krupas' *Oklahoma Herpetology: An Annotated Bibliography* is a helpful addition.

The book contains a preface, introduction, a short checklist, a numbered bibliography, a generic index and an index of common names. The introduction explains the sources and percentage of publications which cover the amphibians and reptiles. The checklist is five pages long and consists of only the scientific and common names of the amphibians and reptiles of Oklahoma. The bibliography is a monumental undertaking which numerically lists a total of 1,536 publications as compared to Webb's (1970) bibliography of 339 listings and Secor's and Carpenter's (1984) updated list of an additional 66 references. Their earliest reference is dated from 1823. The annotated checklist is concerned only with generic names while species and subspecies are not included. Under each generic assignment the authors have categorized (by number) the pertinent fields of study relating to a particular genus which can be cross referenced with the bibliography. These fields include behavior, development, distribution, taxonomy, etc.

The book is hardback with an attractive blue color with a collared lizard, *Crotaphytus collaris*, on the front. The print, although small, is easily read. The paper is of good quality without a gloss. This reviewer could not find any typographical errors.

One major problem exists with the book. Species and subspecies are not represented in the Genus and Key Word Index. For a person working with *Alligator mississippiensis*, American alligator, the citations under the generic name pose no problem. However, if a person is working with a genus with numerous species like *Bufo*, *Hyla*, *Scaphiopus*, *Rana*, *Ambystoma*, *Eurycea*, *Plethodon*, *Graptemys*, *Eumeces*, *Cnemidophorus*, *Nerodia*, or *Thamnophis*, then a problem becomes very acute. For example, if a person is interested in *Thamnophis proximus*, then he would have to look it up in each of the literary citations listed for *Thamnophis* (130 references in this case) to find the ones directly relevant to *T. proximus*. This would be a tedious process.

In spite of these arguments, *Oklahoma Herpetology: An Annotated Bibliography* brings the literature up to date and, for that reason alone, serves a useful purpose. This is a book that belongs on the bookshelf of every professional or serious amateur herpetologist.

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BOOK REVIEW

A Field Guide to Reptiles of Oklahoma by G. Sievert and L. Sievert. 1988. Oklahoma Dept. Wldlf. Conserv., Oklahoma City. 96 pp. $5.00

A Field Guide to Reptiles of Oklahoma is a paperback booklet intended to help identify Oklahoma's common species of reptiles. furthermore, the authors state that it is "...written for the layman and is not intended to be a technical treatise on Oklahoma's reptiles."

This small booklet is small enough and flexible enough to fit into a hip pocket, glove compartment or purse. It contains an introduction stating the author's purpose and containing generalized information on Oklahoma reptiles. This is followed by a four page checklist containing the common and zoological names of the 106 species and subspecies which occur in Oklahoma as well as introduced species. The next portion which makes up most of the text is the species accounts. Each account includes a photograph, common name, scientific name, shaded range map, size, description, comparison with similar species and natural history. The natural history section includes food, habitat and appropriate remarks. Introduced and rare species are not figured and are briefly discussed in the back of the book. A short glossary and brief general bibliography is presented.

The paper is of a good quality with a slight gloss which creates some glare. The print is small but typographical errors are limited, The photographs, with the exception of the alligator, are good in quality. The alligator photograph contains a bad water reflection.

One of this review's pet peeves is the use of the word "poisonous" indicating the dangerous nature of 10 of the 106 reptiles of Oklahoma. The word "venomous" is preferred as opposed to "poisonous".

Not all of the zoological names are up to date. Secor and Carpenter (1984) follow Smith and Brodie (1982) when using the scientific names. Such changes should include changing *Graptemys pseudogeographica ouachitensis* to *G. o. ouachitensis* and *Leptotyphlops dulcis* to *L. myopicus*. In addition, Meylan (1987) advocates the use of *Apalone* instead of *Trionyx* for the generic name of the soft shelled turtles. Therefore, *Trionyx muticus* and *T. spiniferus* are presently considered as *Apalone muticus* and *A. spinifera*. This also follows the nomenclature used by Ernst and Barbour (1989). It should be pointed out in defense of *A Field Guide to Reptiles of Oklahoma* that North American turtle nomenclature is not very stable at this time.

When compared with the county distribution maps of Secor and Carpenter (1984), the reviewer notices a number of discrepancies when compared with the ones by Sievert and Sievert. Many of the taxa are depicted as having a greater range and existing in other counties. No doubt, these are generalized estimates of range and some are even indicative of various published accounts appearing after Secor and Carpenter (1989). Some taxa actually are known to occupy additional counties which are not included in this booklet (i.e. *Kinosternon flavescens*, *Terrapene carolina*, *Eumeces fasciatus*, *Leptotyphlops dulcis* [=*L. myopicus*], *Nerodia sipedon*, and *Agkistrodon piscivorous*). The shorter county range of *Uta stansburiana* and *Thamnophis cyrtopsis* is represented but not *Phrynosoma modestum*. *Regina rigida*, known to occupy at least four counties, is not represented at all. One helpful hint is to examine back issues and future issues of the Bulletin of the Oklahoma Herpetological Society which commonly publishes new county distributions. Finally, all taxa should have been included.

The authors live up to their purpose for writing this booklet. It will serve the layman by helping to identify a particular reptile in Oklahoma. The professional should be wary of the above problems within the text. The maps cannot be used to determine if the reptile recently caught is a new distribution record or not. In spite of the shortcomings, *A Field Guide to the Reptiles of Oklahoma* is a book worth keeping. Let's hope a revised edition will appear in the future.

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—Thomas Vance, Biology Dept., Nasarro College, 3200 West 7th Avenue, Corsicana, Texas 75110

Received: 13 June 1990

BOOK REVIEW

Turtles of the World by C. Ernst and R. Barbour. 1989. Smithsonian Instit. Press. Washington, D.C. 313 pp. ISBN 0-874-414-8. $45.00

Turtles of the World is one of the few modern treatments of the different turtle species as viewed from a world-wide approach. The authors provide descriptions for 257 species of turtles and keys which will identify them.

The hardback book is divided into a preface, introduction, a general chapter on turtle biology, individual accounts keyed to species level, bibliography, glossary and index. Photographs, line drawings and generalized distribution maps are also included within the text.

The preface briefly reviews the history of turtle nomenclature regarding the early monographs written during the 1800's. The works of Gray (1831, 1870), Dumeril, et al. (1835, 1851) and Boulenger (1889) were the first to treat the turtles from a global approach. These were followed in the 1900's by Wermuth and Mertens (1961, 1977), Pritchard (1967, 1979) and Iverson (1986). Many regional checklists and descriptive works also exist.

The text of the introduction is basic as one may expect, however, the information of the preface should have been incorporated into it instead of being presented separately. Appropriately, the authors give brief explanations of the way the book is organized.

The first chapter (although it is not referred to as such) is a general discourse of turtle biology. Here, the authors include diagrams illustrating the nomenclature of the various bones and scutes of the shell as well as presenting the usage of these or similar terms by other workers in the form of a synonymy. Various parts of the head and skull are also illustrated and discussed. Afterward, they present the differences between the pleurodiran and cryptodiran megaorders of turtles which are later separated into families.

The major part of the book is concerned with the discussion of the various species under the family names. Keys are presented which serve to identify the animal to a generic and then a specific level within a particular family. This is followed by the individual species accounts. The scientific names are followed by the authority and date of the original descriptive publication. The common name is given, and the rest of the account contains recognition characters, general distribution, geographic variation, habitat, and natural history. Each account is accompanied by at least one black and white photograph. Brief discussions of subspecies are included in the section concerned with geographic variation, unfortunately, keys are not provided.

A series of 56 colored photographic plates are included in the center of the book, some of which are identified to subspecies level.

A bibliography is presented which contains the major and most important papers on turtles. This is followed by a glossary of scientific names and translations. The index concludes the book.

The paper is of good quality and the print, which is double columned, is large enough to be easily read. The titles and subtitles are in bolder print than the rest of the text. The paper does not reflect much light, hence glare is reduced. The black and white photographs are generally good, but the colored plates are excellent. Typos are not common.

When comparing the last revision of Old and New World turtles (Iverson, 1986) with this book, numerous taxonomic changes are evident. Most of Ernst and Barbour's changes are based on studies not included by Iverson (1986) or are currently under way. Table 1 serves to compare the names as used by Iverson (1986) and in this book. This should emphasize the fact that turtle nomenclature is static and far from stabilization.

The authors state that the purpose of *Turtles of the World* is to present a volume "...summarizing the classification of turtles with clear descriptions and keys to their identification," and "...to be useful to scientists and interested laypersons". They also point out systematic and other problems in order to "...spur research to solve these questions." In essence, this is a companion volume to an earlier book on North American turtles (Ernst and Barbour, 1972).

Sadly, this book lacks distribution maps. Dot maps similar to those of Iverson's (1986) would add much more meaning to understanding the range of a particular species or subspecies.

This reviewer is enthusiastic over *Turtles of the World*. It is a book which accomplishes what the authors have set out to do. It will serve as a useful addition to any biologist's library.

Table 1.

Ernst and Barbour (1989) Nomenclature	Iverson (1986) Nomenclature
Acinixys planicauda	*Pyxis planicauda*
Amyda cartilaginea	*Trionyx cartilagineous*
Amyda ferox	*Trionyx ferox*
Apalone mutica	*Trionyx muticas*
Apalone spinifera	*Trionyx spiniferus*
Aspideretes gangeticus	*Trionyx gangeticus*
Aspideretes hurum	*Trionyx hurum*
Aspideretes leithii	*Trionyx leithii*
Aspideretes nigricans	*Trionyx nigricans*
Cuora chriskarannarum	—
Cuora flavomarginata	*Cistoclemmys flavomarginata*
Cuora galbinifrons	*Cistoclemmys galbinifrons*
Cuora hainanensis	*Cistoclemmys hainanensis*
Cuora mccordi	—
Dogania subplana	*Trionyx subplanus*
Geochelone abingdoni	*Geochelone elephantopus*
Geochelone becki	*Geochelone elephantopus*
Geochelone chathamensis	*Geochelone elephantopus*
Geochelone darwini	*Geochelone elephantopus*
Geochelone ephippium	*Geochelone elephantopus*
Geochelone guntheri	*Geochelone elephantopus*
Geochelone microphyes	*Geochelone elephantopus*
Geochelone hoodensis	*Geochelone elephantopus*
Geochelone nigrita	*Geochelone elephantopus*
Geochelone phantastica	*Geochelone elephantopus*
Geochelone vandenburghi	*Geochelone elephantopus*
Kinosternon carinatum	*Sternotherus carinatus*
Kinosternon depressum	*Sternotherus depressus*
Kinosternon minor	*Sternotherus minor*
Kinosternon odoratum	*Sternotherus odoratus*
Lissemys punctata scutata	*Lissemys scutata*
Nilssonia formosa	*Trionyx formosus*
Pelodiscus sinensis	*Trionyx formosus*
Peltocephalus dumeriliana	*Peltocephalus dumerilianus*
Pelusios broadleyi	—
Pelusios bechuanicus upembae	*Pelusios upembae*
Pelusios castaneus chapini	*Pelusios chapini*
Platemys macrocephala	*Acanthochelys macrocephala*
Platemys pallidipectoris	*Acanthochelys pallidipectoris*
Platemys radiolata	*Acanthochelys radiolata*
Platemys spixii	*Acanthochelys spixii*
Pseudemys concinna texana	*Pseudemys texana*
Rafetus swinhoei	*Trionyx sinensis*
Trachemys dorbigni	*Trachemys scripta dorbigni*

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—Thomas Vance, Biology Dept., Nasarro College, 3200 West 7th Avenue, Corsicana, Texas 75110

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LIZARDS OF THE ORIENT, A CHECKLIST

by Kenneth R.G. Welch; P.S. Cooke & A.S. Wright
Orig. Ed. 1990 $21.50
ISBN 0-89464-327-4

The lizards of the Orient are discussed in this book. Included in this area are Pakistan east to China and south through Asia, to include Japan, the Philippine Islands, Indonesia and Papua New Guinea. This list, which relies heavily on published material, is presented to herpetologists as an encouragement for further study. An index to genera, species and subspecies is included, as well as references.

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VOL. 1: Synopsis of Snake Generic Names

Orig. Ed. 1989 244 pp. $31.50

ISBN 0-89464-215-4

VOL. 2: Synopsis of Living and Extinct Species

Orig. Ed. 1991 $33.50

ISBN 0-89464-216-2

This long-awaited work comprises an alphabetical list of living and fossil, generic and sub-generic snake names, living and extinct species, emendations, and spelling variations. Type species designations are provided for all original descriptions. Each name is furnished with its family allocation (if valid) or senior synonym (if invalid), and bibliographic references are included. A literature review is presented for controversial names. An invaluable reference for the amateur and professional zoologist, natural history museums and libraries. Bibliography includes references that include original descriptions of all valid species and references used in text.

BIOMEDICAL AND SURGICAL ASPECTS OF CAPTIVE REPTILE HUSBANDRY

by Fredric L. Frye

Orig. Ed. 1981 468 pp. $62.50

ISBN 0-935078-01-0

In this volume, extensive attention is given to how reptiles can be maintained in a healthy state and how to diagnose and treat sick or injured ones. Included is much new information reflecting recent advances in veterinary medical management of reptiles. The chapters devoted to preventive medicine are those on husbandry, nutrition and food preferences. Clinical studies, with cause and treatments for specific disorders, are found in sections devoted to hematology; hemic and nonhemic parasitology; algal, fungal, bacterial and viral diseases; and noninfectious medical conditions. Radiology, ophthalmology and traumatology receive considerable attention. Chapters on anesthesiology, surgery, reproduction, and reproductive physiology reflect other major topics receiving extensive discussion.

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GECKOES
by Herbert Rosler
Orig. Ed. 1990 Not Set
ISBN 0-89464-365-7

Although written in a generally scientific way, this text gives essential information about geckoes to the amateur reptile fancier as well as to the specialist herpetologist. The most important factors here are the biology of the geckoes and their maintenance and reproduction in the vivarium. As well as frequently-kept species, representatives of the rarities of this group of lizards from five continents will be introduced. Each of the species discussed will be accompanied by a photograph from the author's extensive collection.

HANDBOOK ON THE MAINTENANCE OF REPTILES IN CAPTIVITY
by Kenneth R.G. Welch
Orig. Ed. 1987 162 pp. $19.50
ISBN 0-89874-830-5

The aim of this text is to act as a guide, a base for the beginner, and at least in part, a handbook for the more experienced reptile keeper. The text is divided into four parts. The first is an introduction to the maintenance of reptiles in captivity; the second is supplementary notes to the introduction; the third, specific accounts on keeping a selection of reptiles in captivity; and finally, there is a list of species, with references on their maintenance in captivity, breeding results, behavior, ecology, and other subjects considered necessary knowledge to aid in keeping those species in captivity.

HERPETOLOGY OF AFRICA: A Checklist and Bibliography of the Orders Amphisbaenia, Sauria, and Serpentes
by Kenneth R.G. Welch
Orig. Ed. 1982 304 pp. $26.50
ISBN 0-89874-428-8

This checklist is a guide to the nomenclature and distribution of the amphisbaenids, lizards, and snakes of Africa, Madagascar, and adjacent islands. Nearly 1700 species and subspecies are assigned to 240 genera. References are given for the genera as units, and references with present known distribution for the species and subspecies, to include important synonyms. In addition, references are given for families and countries. There is a comprehensive index, and a bibliography of over 1600 references.

HERPETOLOGY OF EUROPE AND SOUTHWEST ASIA: A Checklist and Bibliography of the Orders Amphisbaenia, Sauria and Serpentes
by Kenneth R.G. Welch
Orig. Ed. 1983 144 pp. $17.50
ISBN 0-89874-533-0

This book is a companion volume to HERPETOLOGY OF AFRICA and complements the African title both taxonomically and zoogeographically. The text contains 93 genera, 700 species and subspecies, and has a bibliography of nearly 1000 references.

SNAKES OF THE ORIENT, A CHECKLIST
by Kenneth R.G. Welch
Orig. Ed. 1988 192 pp. $26.50
ISBN 0-89464-203-0

The Orient has for many years been greatly neglected by herpetologists, compared to the rest of the world. Presented in this book is a list of the snakes of the area to be used as an encouragement for further study. In this work an attempt is made to list the snake fauna of the Orient as a whole (Pakistan, east of China, south through Asia, to include Japan, Philippine Islands, Indonesia, and Papua New Guinea.) The list includes present-day names, original names and references, type locality, distribution, and any recent taxonomic references.

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THE ROLE OF MODERN ZOOS BROUGHT TO LIFE IN A BEAUTIFULLY ILLUSTRATED VOLUME

- *A horse in the Louisville Zoo gave birth to a zebra, while in Cincinnati an antelope gave birth to a bongo -- thanks to embryo transplants, the latest in zoological research.*
- *A typical week's order from the keeper at the National Zoo in Washington might include 100 pounds of marlins and 30,000 crickets.*
- *More than 112 million people visit zoos and aquariums annually in North America. That attendance rate exceeds the number of individuals who attend professional football, basketball, and baseball games combined each year.*
- *An unrelated male and female gorilla reared together since childhood will -- when adults -- often regard each other as siblings, therefore instinctively refusing to mate.*

Gone are the days when a zoo was merely a place where as many species as possible were cramped into sterile cages. Today's zoos are built to save animals from extinction by providing natural habitats and ample breathing space to encourage the animals to feel comfortable and breed. In fact, many animals born in captivity are now released into the wild, giving their species a better chance for survival.

ZOO: THE MODERN ARK (Publication date: June 1, 1990; $35.00 hardbound), by noted natural history writer Jake Page and award-winning photographer Franz Maier, with an Introduction by Gerald Durrell, is the first book to chronicle in depth the latest developments in zoo research and highlight some of the most progressive and beautiful zoos in the world.

From white rhinoceri to Bengal tigers, from the sacred baboon to the hyacinthe macaw, this comprehensive volume takes the reader on a remarkable journey through the world of rare and wondrous animals. With historical photographs and stunning full color illustrations **ZOO: THE MODERN ARK** traces the history of zoos from 2300 B.C. to the present and discusses their current role in educating the public and participating in the latest scientific research. The book also discusses how animals are reared and fed and the high-tech methods now used in breeding.

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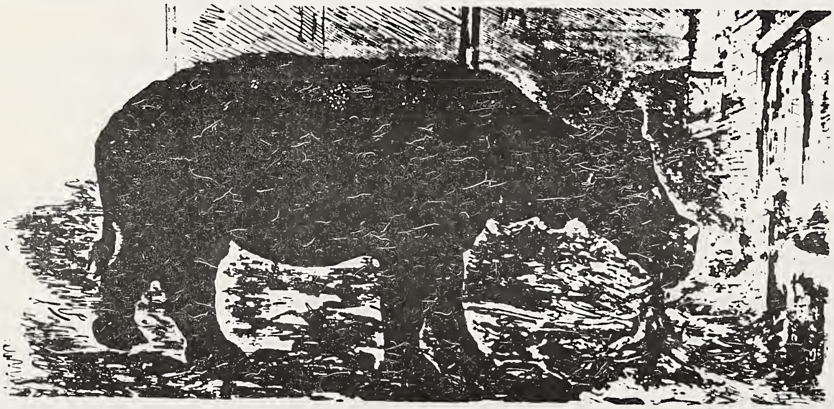
- *The Frankfurt Zoo now boasts an exatorium -- a large building that includes climatic panoramas, stunning aquaria, and darkened reptile halls.*
- *The Jersey Wildlife Preservation Trust features the first 500-acre open air zoo where animals can roam freely.*
- *Australia's Torango Zoo provides life-like enclosures for koalas that are dressed each day with fresh eucalyptus leaves and bark, while visitors observe from a helical ramp.*
- *The ape habitat in Toronto takes visitors along a lush and steamy rain forest path, in which the animals can be viewed from an unusually close proximity, while the Brookfield Zoo in Chicago supplies artificial thunder and rain!*

From the San Diego and Philadelphia Zoos to the Ueno Zoological Gardens in Tokyo and the Auckland Zoological Park in New Zealand, **ZOO: THE MODERN ARK** brings to the general reader, animal enthusiast, and zoologist alike not only a rich historical appreciation of zoos, but also a new and profound understanding of their increasingly important role in saving endangered species.

Jake Page is a leading figure in the field of natural history and the founding editor of the Natural History Press and Smithsonian Books. His work has been featured in Natural Geographic, Smithsonian, Readers' Digest, McCall's, Omni, and many other publications. **Frank Maier** is a noted Australian press photographer who has won numerous national and international awards. His film pursuits include, among others, a documentary made in a previously closed-off province of India and a film on the wild tigers of Kashmir.

ZOO: THE MODERN ARK by Jake Page
Photographs by Franz Maier
Publication Date: June 1, 1990; Price: $35.00 hardbound
130 full-color photographs, illustrations, line drawings, and maps.
Names and addresses of zoo and wildlife education programs and organizations.
Appendix; Bibliography; 192 pp. 9 x 12.; ISBN: 0-8160-2345-X



According to the article that accompanied this illustration in *Harper's Weekly*, in May 1874, the Zoological Society of London paid £4,000 for this "Javan" rhinoceros — a hefty sum.

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Volume 27 Number 1 March 1991

SURVEY OF THE REPTILIAN FAUNA OF THE KINGDOM OF SAUDI ARABIA. III. AN ECOLOGICAL SURVEY OF THE LIZARD, AMPHISBAENIAN AND SNAKE FAUNA OF AL-ZULFI AREA.

M. K. Al-Sadoon, S. A. Al-Farraj* & N. M. abdo

Abstract

Reptilian fauna of Al-Zulfi area has been surveyed. Study of the area was done through the collection of 19 species of amphisbaenians and 9 species of snakes belonging to 5 families. Physiography and climate have been investigated. Geographical distribution of these species within this area was mapped.

Introduction

At one time the herpetofauna of Saudi Arabia was very poorly known, but due to the steady accumulation of collections and painstaking studies (Parker, 1933; 1938; Schmidt, 1941; Hussein, 1966; Mandaville, 1967; El-Wailly and Al-Uthman, 1971; Gasperetti, 1974; 1977; 1988; Leviton, 1977; Farag and Banaja, 1980; Arnold, 1986; Al-Sadoon, 1988; 1989), our knowledge of these animals has greatly improved. Nevertheless, organized surveys are still badly need to fill in the gaps created by the previous sporadic contributions. To date 92 species of Lizards, 52 species of snakes, 7 species of Amphibia and 2 each of fresh water Chelonians and Amphisbaenians have been reported from Arabia (Arnold, 1987).

In this third part of the series of surveys of the reptilian fauna of Saudi Arabia, the lizards, snakes and Amphisbaenians of Al-Zulfi area are reported. The approach to this survey is focused on Saudi Arabia, through the central region and down to this selected area.

Material and Methods

Specimens which furnished the basis of the present study were caught alive from different localities of Al-Zulfi area during 1986 to 1988. Some of the species were maintained in large cages with food and water provided *ad. lib.* The animals were identified using the keys of Arnold (1986) and the identifications were confirmed by Dr. E.N. Arnold, Dept. of Zoology, British Museum of Natural History and by Mr. John Gasperetti of the California Academy of Sciences.

Physiography

Al-Zulfi area is located in the Central Region of Saudi Arabia with a total area of about 20,000 Km² lying between approximately 26° 40' and 26° 30' N and 44° 40' and 45° E. There are four distinct habitats: sand dunes, open land (prairie), rocky mountains and cultivated areas.

The sand dunes are mostly mobile lunar shaped and with no apparent drainage valleys. They are made up of deep sandy non-saline to weakly saline soil with relatively low water storage capacity. They belong to the northern Nafud Desert System comprising three parallel protrusions, Nafud Al-Thuwayrat, Nafud Al-Sirr and Nafud Al-Shiqaiqa that extend in a northwest-southwest direction over an area of 9640 Km² and an altitude of 650-798 meters above sea level. The biggest of these is Al-Thuwayrat, Arabic name for revolutionary due to its restless habit of not conforming to a definite shape or direction for more than a week, especially during windy summers. These sand dunes lack proper flora due to extremely meager rainfall and excessive evaporation coupled with the poor water storage capacity of the loose sand that is easily blown away by strong winds and storms (Al-Oadat *et al.*, 1985). Animals in general and reptiles in particular are very few in such an environment that lacks a green cover needed by most reptiles. Hence, the few reptiles around are mostly of the burrowing type.

The open lands comprise vast areas of evenly levelled to slightly sloping lowlands devoid of Sand dunes and valleys. These are formed in the periphery of mountaineous areas due to excessive drought and erosion and they contain gravel and stones in some places. Some of these open lands have a reasonable vegetational cover, while others have scarcely any plants.

The rocky habitats are of considerably high altitude with several bare mountain ranges, especially in those areas of scarce rain. This is represented by Tuwaiq mountain range which is 708 metres high at Khashm Um Al-Khud and is extending in an eastern direction. This range of sedimental rocks occupies some 800 Km and forms an arc in the Central Region. There are several valleys draining the range such as the valleys of Markh, Simnan, Oraiera and Swes.

The cultivated areas comprise some 5000 plantations of mostly date palm trees occupying 14359 hectar (Al-Yousif, 1985). These irrigated areas have furnished an excellent environment for many animals such as lizards and arboreal snakes. Many of these plantations extend into Nafud Al-Thuwayrat where several villages have developed and some of their deserted houses have represented excellent homes for many species of geckos.

Climate

Saudi Arabia has a dry tropical and subtropical desert climate of the Eastern Mediterranean type. Moreover, inland position of the study area has bestowed it with a continental weather of temperature extremes from 5°C in January to 42°C in July (Fig. 1), a mean annual precipitation of 25-30 mm in winter (Fig. 2) and a mean relative humidity of 15-55% (Fig. 3).

The effects of winds depend mainly on their direction, which is in turn mostly affected by low pressure zones similar to those of India, Iran, Arabian Gulf, the Ethiopian Plateau and Cyprus. Northernly winds with high temperature dominate during summer and intermittent southernly winds during spring. In winter the cold Nasreen winds from Siberia blows in a northern and northern easternly direction due to high pressure zones developing in the Arabian Peninsula and can cause a lot damage to plant and animal life (Al-Yousif, 1985). The average wind speed varies from 2-4 Km/hr in summer to 6-7 km/hr in winter.

Systematic Account

Order Squamata

Sub-order Sauria

Nineteen lizard species, belonging to five families were collected from the various locations sampled at Al-Zulfi area and their geographical distribution within this area was mapped.

Family Agamidae

This family is represented by four species:

Agama (Trapelus) blanfordi fieldi (Hass & Werner, 1969).

This striped agama inhabits rocky habitats, previously reported from the Northern Region of Saudi Arabia and from Riyadh Province (Al-Sadoon, 1988).

Localities: Al-Ogff, Sheb Swes, Sheb Gzrah and Eryra (Fig. 4).

Agama (Pseudotrapelues) sinaita (Heyden, 1827).

This desert rock agama inhabits hills, escarpment slopes and rocky valleys (Wadis). It has been reported from Al-Taif and Baljarashi (Farag and Banaja, 1980) and from Riyadh Province (Al-Sadoon, 1988).

Localities: Sheb Gzrah (Fig. 4).

Phrynocephalus arabicus (Anderson, 1894)

This toad-headed agama inhabits sand dunes around Al-Zulfi. It was previously reported from various locations in Riyadh Province (Al-Sadoon, 1988).

Localities: Al-Joway, Nafud Al-Sabalah, Al-Khalil and Gzrah (Fig. 4).

Uromastyx aegyptius microlepis (Blanford, 1874).

This spiny tailed lizard is an inhabitant of arid regions and flat plains. It has been reported from Jeddah, Madinah, Yanbu and Wadi Fatimah (Farag and Banaja, 1980) and from various locations of Riyadh Province (Al-Sadoon, 1988).

Localities: Sheb Alka, Alka, Al-Sabalah, Sheb Markh and Sheb Swes (Fig. 4).

Family Gekkonidae

This family is represented by five species:

Bunopus tuberculatus (Blanford, 1874).

The tuberculated sand gecko inhabits sandy areas and sometimes found under metal sheets or rubbish. It has previously been reported from various localities in Riyadh Province (Al-Sadoon, 1988).

Localities: Al-Grdah, Sheb Gzrah, Sheb Markh, Nafud Al-Sabalah, Alka and Sheb Swes (Fig. 5).

Bunopus spatulurus spatulurus (Anderson, 1901).

The sand gecko is an inhabitant of sandy areas and has been reported from North and South Yemen as well as from Dhofar region of the Sultanate of Oman (Arnold, 1986). The present record of this species in Al-Zulfi area is the first from the Central Region of Saudi Arabia.

Localities: Khaser Saud and Eryra (Fig. 5).

Hemidactylus turcicus (Linnaeus, 1758).

This disc-fringed gecko is found under stones and metal sheets. It has been reported from Al-Riyadh (Arnold, 1986) and from Sadus and Al-

Zulfi (Al-Sadoon, 1988).

Localities: Alka and Al-Zulfi (Fig. 5).

Ptyodactylus hasselquistii (Donndorff, 1798).

This fan-footed gecko inhabits buildings, wadis, escarpments and rocky areas. It has been reported from Al-Taif, Jeddah and Wadi Fatimah (Farag and Banaja, 1980) and from various localities of Riyadh Province (Al-Sadoon, 1988).

Localities: Al-Athla, Al-Grdah, Alka, Al-Joway and Mleh (Fig. 5).

Stenodactylus doriae (Blanford, 1874).

This sand gecko inhabits sandy areas and is widespread in Arabia (Arnold, 1986). Its present records from Al-Zulfi are the first from the Central Region of Saudi Arabia.

Localities: Al-Joway and Al-Sabalah (Fig. 5).

Family Lacertidae

This family is represented by five species:

Acanthodactylus boskianus (Daudin, 1802).

This fringe-toed lizard inhabits wadis and vegetated areas. It has been reported from Jeddah and Makkah (Farag and Banaja, 1980) and from various locations in Riyadh Province (Al-Sadoon, 1988).

Localities: Khaser Saud, Sheb Swes Sheb Mleh, Al-Seah, Sheb Alka, Sheb Gzrah, Sheb Markh and Al-Sabalah (Fig. 6).

Acanthodactylus schmidti (Hass, 1957).

This blue-tailed, fringe-toed sand lizard inhabits sand dunes around Al-Zulfi. It has been reported from Dhahran, Abqaiq, Qatif, North of Tabuk, Wadi Fatimah and Makkah (Farag and Banaja, 1980). It has also been sampled in various localities in Riyadh Province (Al-Sadoon, 1988), as well as from Al-Zulfi, Al-Dawadmi and Muzahmiah (Aldakhil and De Silva, 1988).

Localities: Al-Athla, Al-Mur, Al-Joway, Gzrah, Al-Oklah, Kosiba and Nafud Al-Sabalah (Fig. 6).

Acanthodactylus opheodurus (Arnold, 1980).

This striped, fringe-toed lizard inhabits open deserts, rocky terrain and vegetated wadis. It has previously been recorded from different localities in Riyadh Province (Al-Sadoon, 1988).

Localities: Sheb Swes, Sheb Mleh, Al-Seah, Sheb Gzrah, Alka, and Al-Sabalah (Fig. 6).

Mesalina brevirostris (Blanford, 1874).

This lizard inhabits vegetated sandy and gravel plains. It has previously been reported from Al-Wajh (Farag and Banaja, 1980) and from Al-Zulfi, Al-Quwayiyah, Al-Kharj and Layla (Al-Sadoon, 1988) as well as from the Eastern Province of Saudi Arabia (Ross, 1988).

Localities: Sheb Samnan (Fig. 6).

Mesalina guttulata (Lichtenstein, 1823).

This spotted rock lizard inhabits rocky areas and has been reported from Wadi Baish and Jizan (Farag and Banaja, 1980), as well as from Layla, Al-Thimamah, Al-Quwayiyah, Al-Zulfi and Ushayrah (Al-Sadoon, 1988) and from the Eastern Province of Saudi Arabia (Ross, 1988).

Localities: Sheb Gzrah, Sheb Markh, Samnan and Eryra (Fig. 6).

Family Scincidae

This family is represented by four species:

Chalcides ocellatus (Forskal, 1775).

This ocellated skink inhabits cultivated habitats. It has previously been reported from Riyadh Province (Al-Sadoon, 1988), Jeddah, Yanbu, Ribigh and Abha (Farag and Banaja, 1980) and from Unaiyzah (Arnold, 1986).

Localities: Al-Ogff, Alka and Al-Athla (Fig. 7).

Mabuya brevicollis (Wiegmann, 1837).

This red-throated skink inhabits irrigated cultivated habitats and has been been reported from various localities in Riyadh Province (Al-Sadoon, 1988), and from Al-Taif and Buraydah (Arnold, 1986).

Localities: Al-Athla, Al-Joway, Sheb Alka, Al-Ogff, Alka, Eryra, Sheb Swes, Khaser Saud and Al-Zulfi (Fig. 7).

Scincus mitranus mitranus (Anderson, 1871).

This sand fish lizard inhabits the sand dunes around Al-Zulfi and has been reported from Unaiyzah, Al-Hassa and Northern Region of Saudi Arabia (Arnold, 1986) as well as from various location in Riyadh Province (Al-Sadoon, 1988).

Localities: Al-Joway, Al-Khalil, Gzrah, Al-Grdah and Al-Athla (Fig. 7).

Scincus scincus conirostris (Blanford, 1881).

This sand fish lizard inhabits the sand dunes around Al-Zulfi, and is known throughout southern and northern Arabia (Arnold, 1986) and from various localities in Riyadh Province (Al-Sadoon, 1988).

Localities: Al-Khalil and Kosiba (Fig. 7).

Family Varanidae

This family is represented by a single species:

Varanus griseus griseus (Daudin, 1802).

This desert monitor was collected from the various habitats sampled in the present study. It has previously been reported from several localities in Riyadh Province (Al-Sadoon, 1988) as well as from Wadi Fatimah (Farag and Banaja, 1980).

Localities: Sheb Mleh, Sheb Swes, Sheb Gzrah, Kosiba and Al-Sabalah (Fig. 8).

Sub-Order Amphisbaenia

A single species was collected in the present study from Al-Zulfi area.

Family Trogonophidae

This family is represent by a single species:

Diplometopon zarudnyi (Nikolski, 1907).

This worm lizard inhabits sand dunes and damp soils. Hence, its main distribution is along the coast of the Arabian Gulf (Arnold, 1986), but has also been reported from several localities in Riyadh Province (Al-Sadoon, 1988).

Localities: Al-Oklah, Kosiba, Sheb Gzrah, Sheb Swes and Al-Sabalah (Fig. 8).

Sub-Order Serpentes

Nine snake species, belonging to five families were collected from the various localities sampled in Al-Zulfi area and their geographical distribution within this area was mapped.

Family Atractaspididae

This family is represented by a single species in Al-Zulfi area:

Atractaspis microlepidota engaddensis (Hass, 1950).

This oasis mole viper or burrowing asp inhabits cultivated areas and has previously been reported from Al-Diriyah (Al-Sadoon, 1989) and from Hail (Gasperetti, 1988).

Localities: Kosiba and Sheb Mleh (Fig. 10).

Family Boidae

This family is represented by a single species in Al-Zulfi area:

Eryx jayakari (Boulenger, 1888).

This Jayaker's sand boa was found inhabiting sand dunes around Al-Zulfi. It has previously been reported from southern Hijaz, Jeddah and Dhahran-Abqaiq area (Gasperetti, 1974) as well as from the Central Region (Al-Sadoon, 1989).

Localities: Al-Joway, Kosiba, Al-Athla, Al-Grdah and Nafud Al-Sabalah (Fig. 10).

Family Colubridae

This family is represented by five species:

Coluber elegantissimus (Gunther, 1878).

This whip snake inhabits sandy areas and has been reported from

Yanbu and Al-Hawiyah (Farag and Banaja, 1980) and from El-Muwaylih, Nabhaniyah, Aqabah and Al-Taif-Abha Road (Gasperetti, 1974) and from Al-Riyadh, Al-Majmaah and Al-Bukayriah (Al-Sadoon, 1989).

Localities: Eryra (Fig. 9).

Lytorhynchus diadema arabicus (Hass, 1952).

This leaf-nose snake inhabits sandy places near gravel patches. It has been reported from Dhahran, Abqaiq, Jeddah, Ras-As-Shara Al-Qahmah, Halaban, Al-Khubara and Al-Qurayn (Gasperetti, 1974) as well as from Zaymah and Hadda (Farag and Banaja, 1980) and from Shagra, Al-Riyadh and Al-Zulfi (Al-Sadoon, 1989).

Localities: Kosiba, Al-Oklah and Sheb Swes (Fig. 9).

Malpolon moIilensis (Reuss, 1834).

This moila snake or false cobra inhabits sandy and rocky areas. It is widely distributed throughout Saudi Arabia (Farag and Banaja, 1980; Gasperetti, 1988; Al-Sadoon, 1989).

Localities: Kosiba, Al-Oklah, Sheb Swes, Al-Athla, Alka and Al-Sabalah (Fig. 9).

Psammophis schokari schokari (Forskal, 1775).

This striped racer snake inhabits vegetated areas and has previously been reported from Dhahran, Al-Qatif, Hail, Afif, Jeddah, Ras-As-Shara, Burayman and Jizan (Gasperetti, 1988) as well as from Wadi Fatimah (Farag and Banaja, 1980) and from various localities in the Central Region of Saudi Arabia (Al-Sadoon, 1989).

Localities: Al-Oklah, Al-Joway, Eryra, Kosiba, Sheb Swes and Al-Sabalah (Fig. 9).

Spalerosophis diadema cliffordi (Schlegel, 1837).

This clifford's snake inhabits sandy places and has been reported from the Northern Red Sea coast Jeddah and southern Hijaz (Gasperetti, 1976) as well as from Duba and Abha (Farag and Banaja, 1980) and from various localities in the Central Region of Saudi Arabia (Al-Sadoon, 1989).

Localities: Al-Athla, Kosiba, Alka, Sheb Swes and Al- Sabalah (Fig. 9).

Family Elapidae

This family is represented by a single species:

Walterinnesia aegyptia (Lataste, 1887).

This black desert cobra inhabits arid desert areas. It has been reported from Riyadh, Al-Thughba, Wadi Qatan, Ain Dar, Al-Mishaab (Gasperetti, 1976) and from the Central Region (Al-Sadoon, 1989).

Localities: Sheb Swes (Fig. 10).

Family Viperidae

This family is represented by a single species:

Cerastes cerastes gasperetti (Leviton & Anderson, 1967).

This common sand viper inhabits sand dunes and has been reported from Jizan, Ummlij, Dirs (Farag and Banaja, 1980) as well as from localities in the Central Region (Al-Sadoon, 1989) and from Bishah, Jabrin, Abqaiq, Dhahran, Al-Jubayl, Badanah and Mahd Al-Dahab (Gasperetti, 1974).

Localities: Al-Gradh, Al-Athla, Kosiba, Al-Joway, Sheb Gzrah, Sheb Swes and Al-Sabalah (Fig. 10).

Acknowledgments

The authors are greatly indebted to Prof. H. S. Hussein for critically reading the manuscript. Thanks are also due to Dr. E. N. Arnold of the British Museum of Natural History for identifying some of the preserved specimens and to Jamal Tulba, Ahmed F. Al-Bab and Mohammed Eissa for technical assistance.

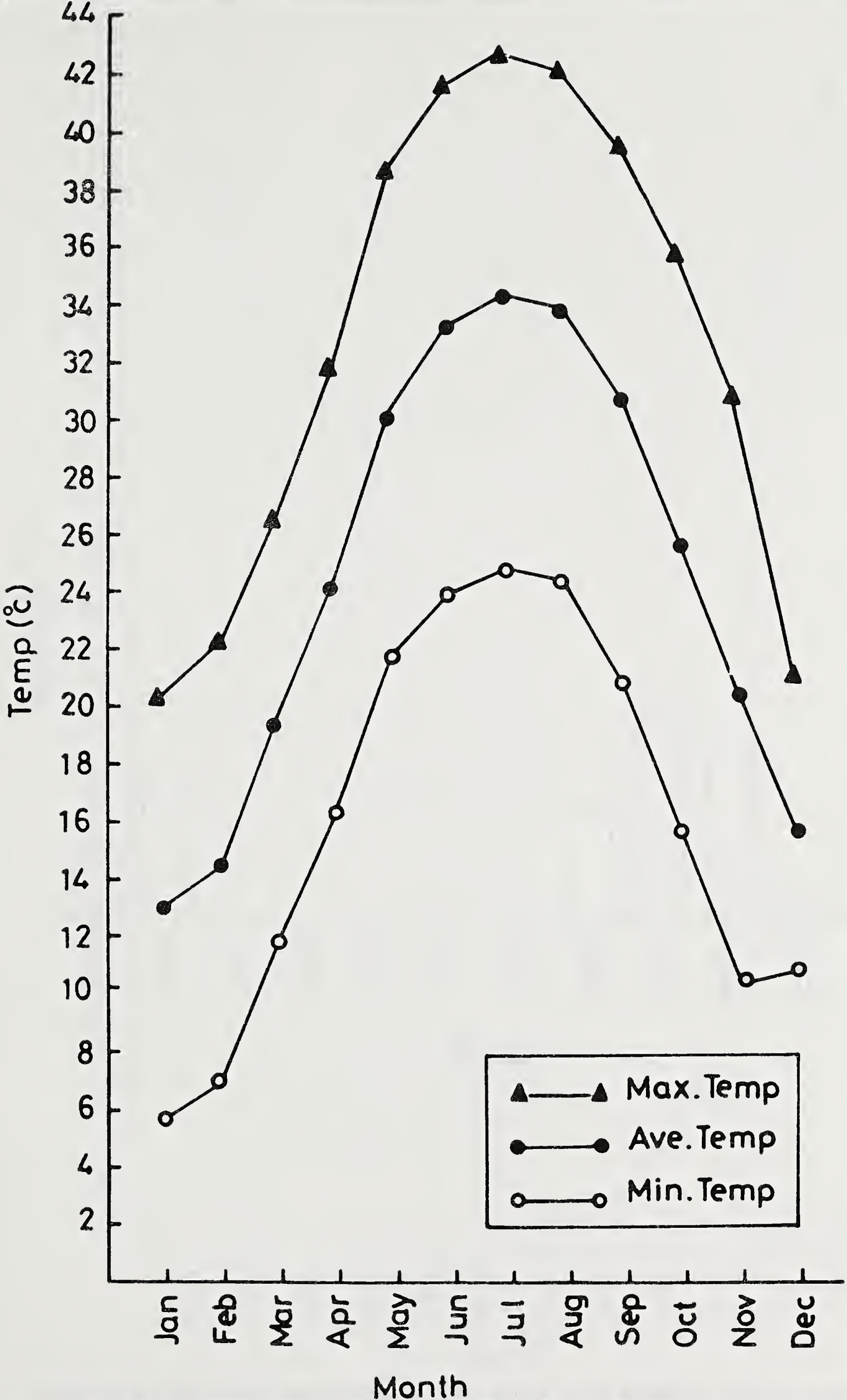

Fig. 1. Mean monthly air temperature (C°) at Al-Zulfi area. Records pooled over the period of one year, from four years' data (1983-1986).

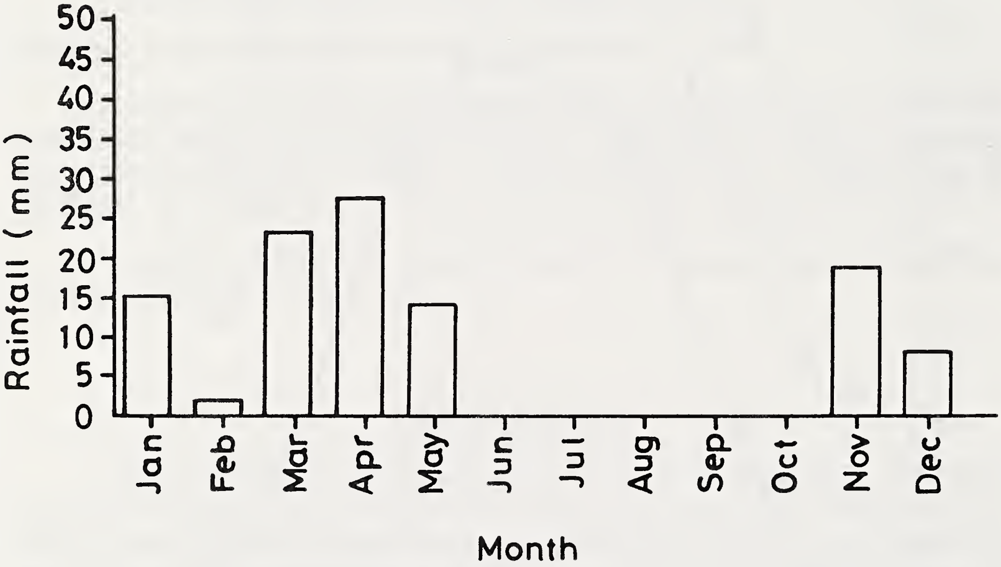

Fig. 2. Mean monthlyrainfall at Al-Zulfi area. Records pooled over the period of one year, from four years' data (1983-1986).

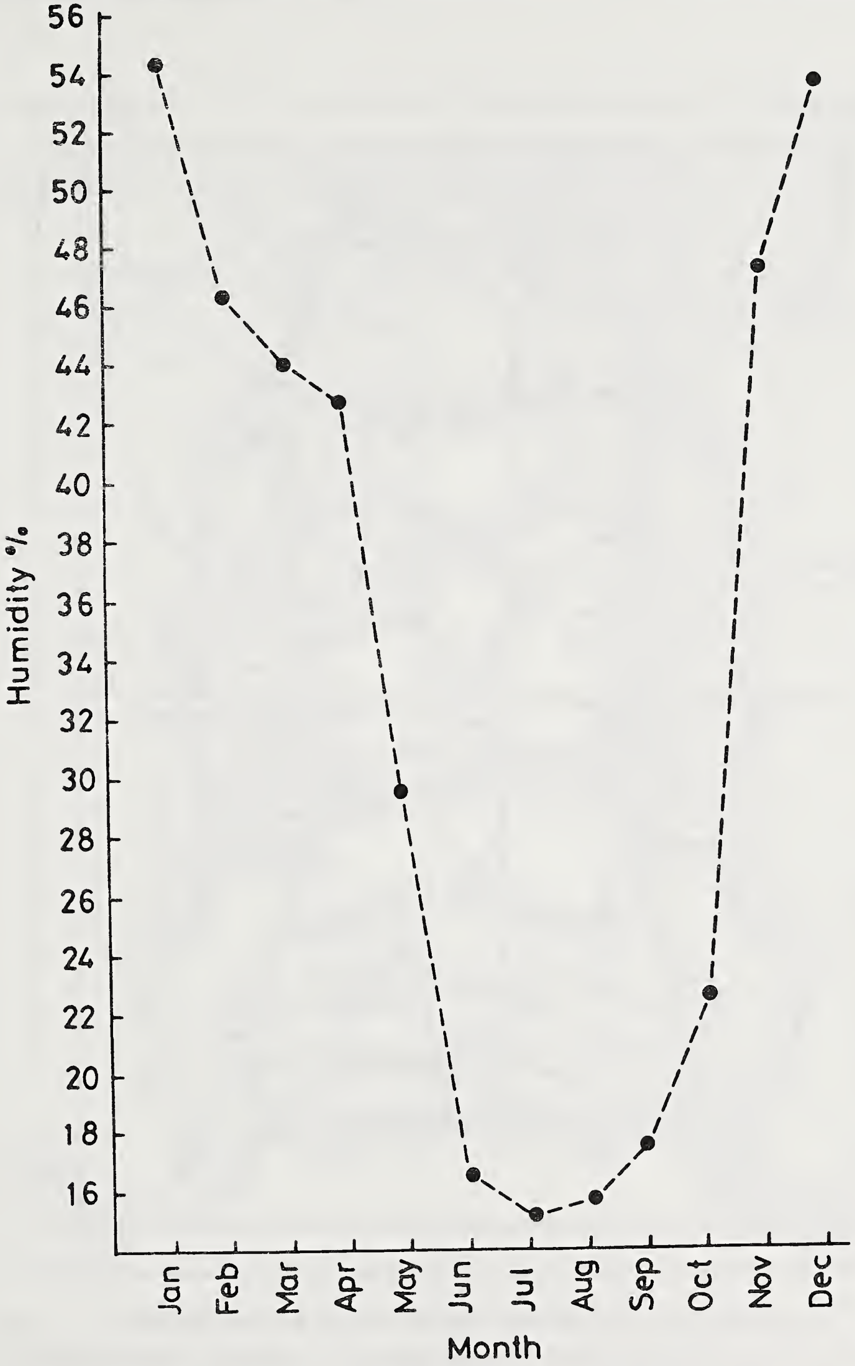

Fig. 3. Mean monthly humidity % at Al-Zulfi area. Records pooled over the period of one year, from four years' data (1983-1986).

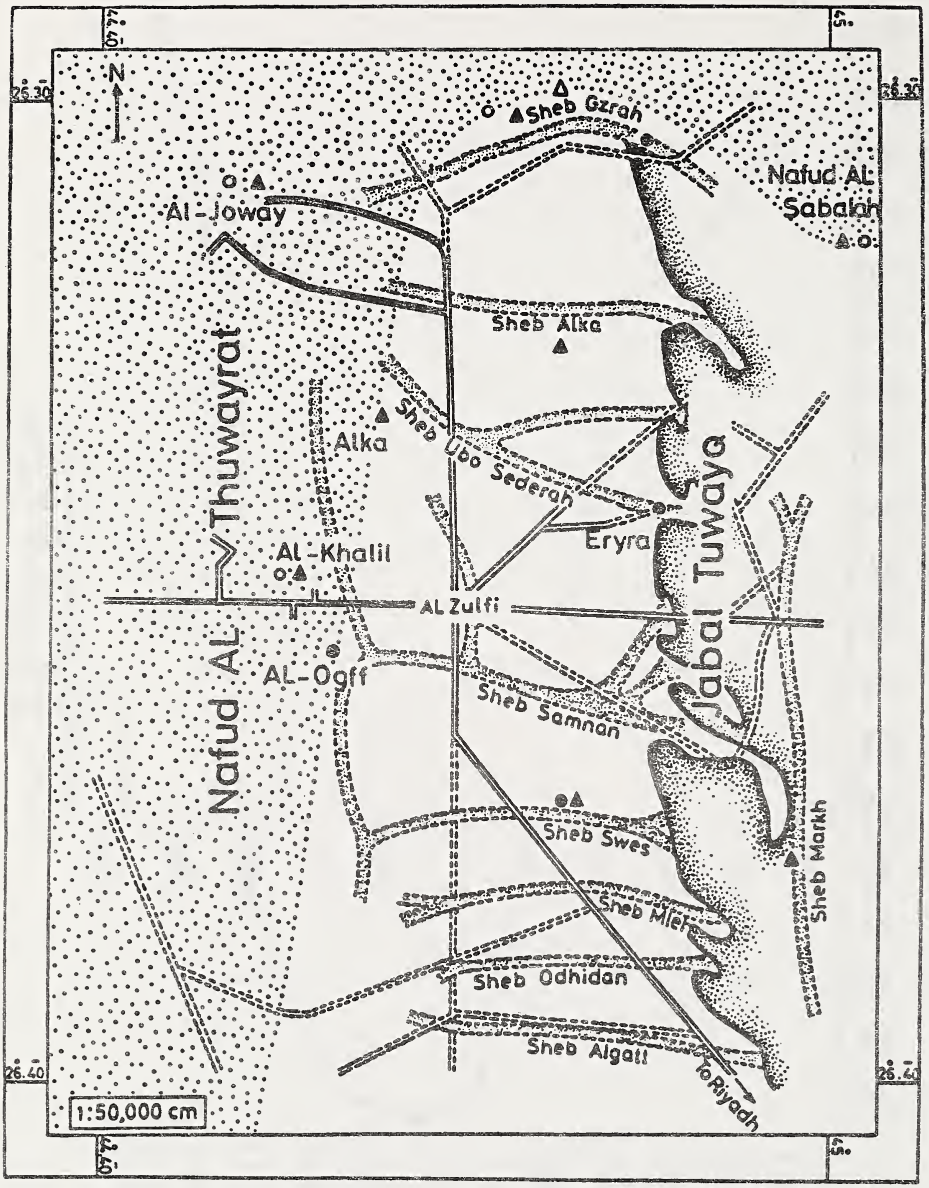

Fig. 4. Distribution of family Agamidae in Al-Zulfi area:
(●) A.b. fieldi; (○) P. arabicus; (▲) U. a. microlepis;
(△) A. sinaita.

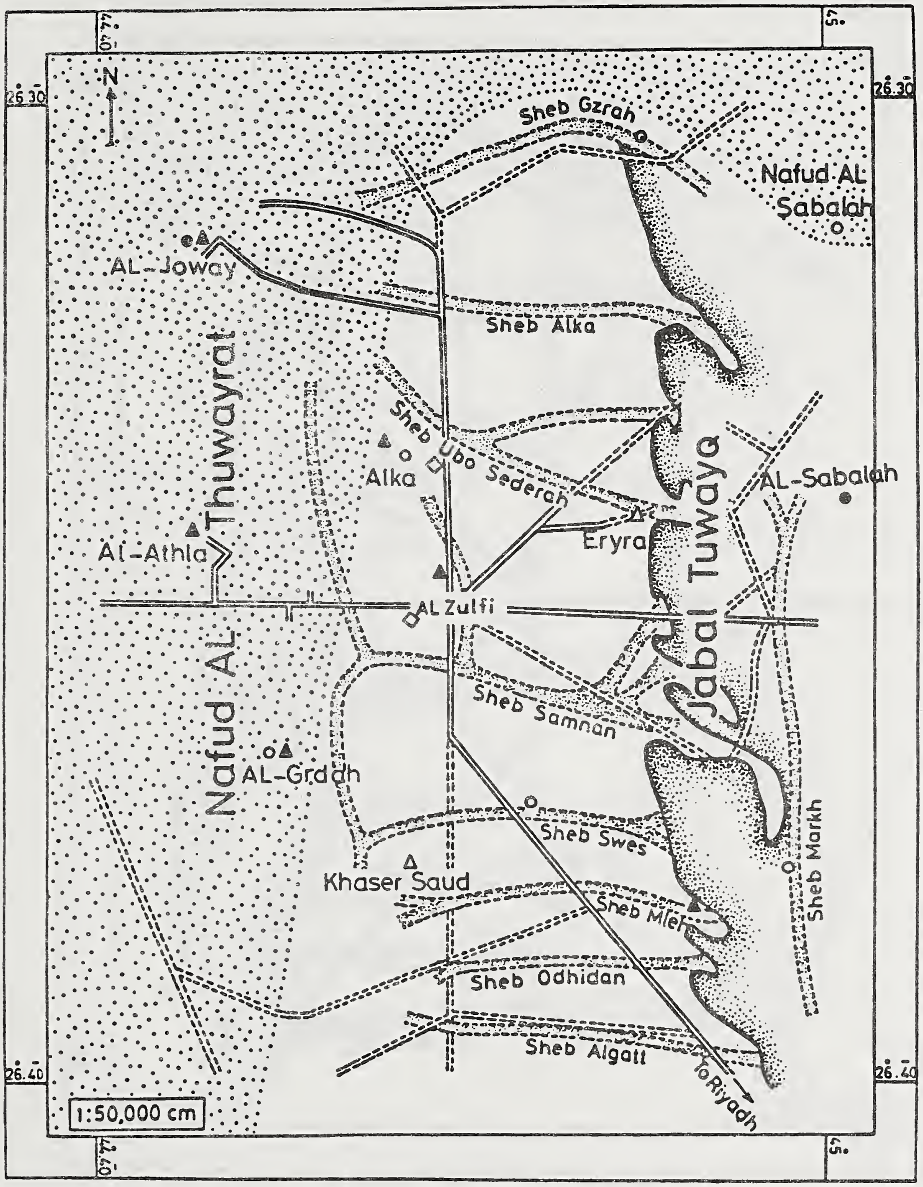

Fig. 5. Distribution of family Gekkonidae in Al-Zulfi area: (●) S. doriae; (○) B. tuberculatus; (▲) P. hasselquistii; (△) B.s. spatalurus; (◇) H. turcicus.

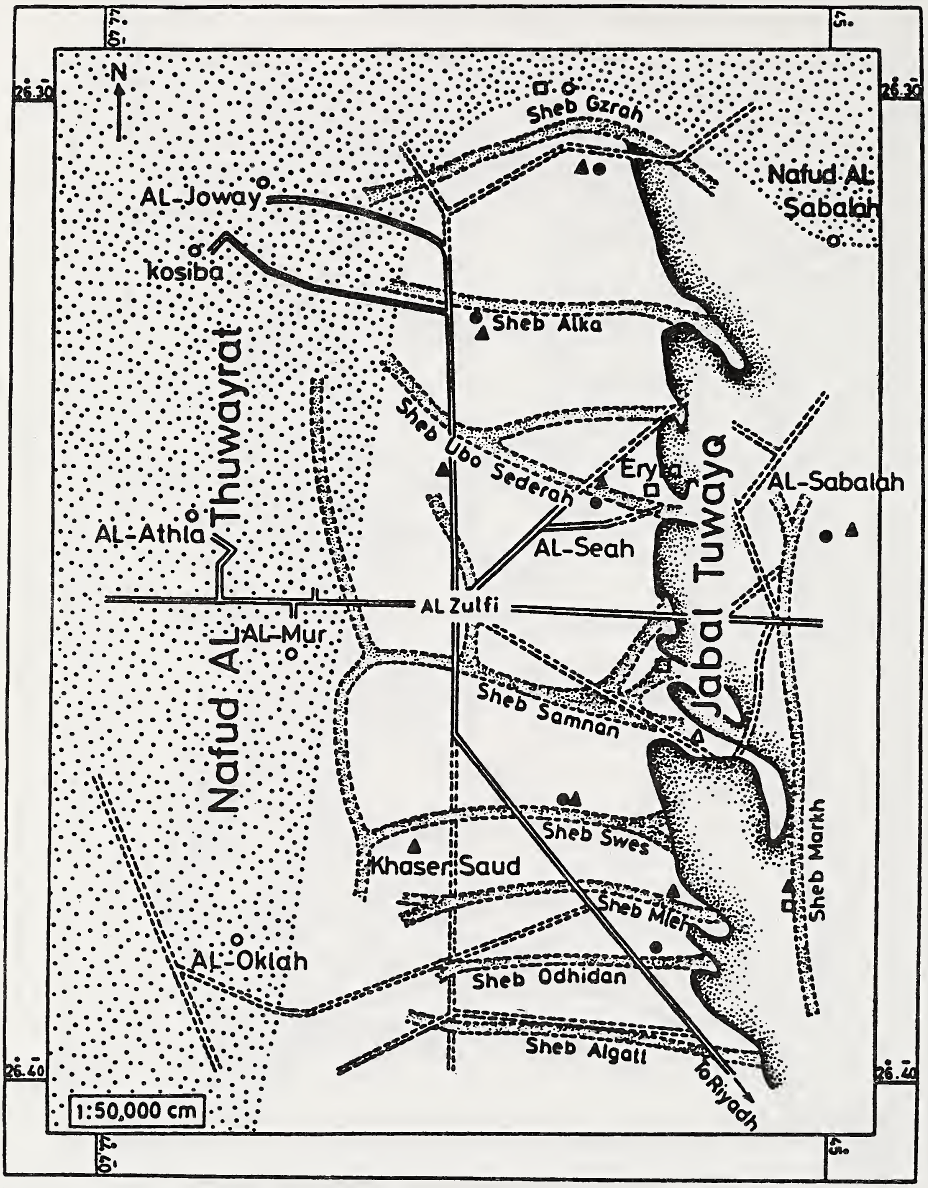

Fig. 6. Distribution of family Lacertidae in Al-Zulfi area: (●) A. opheodorus; (o) A. schmidti; (Δ) M. brevirostris (▲) A. boskianus ; (□) M. guttulata.

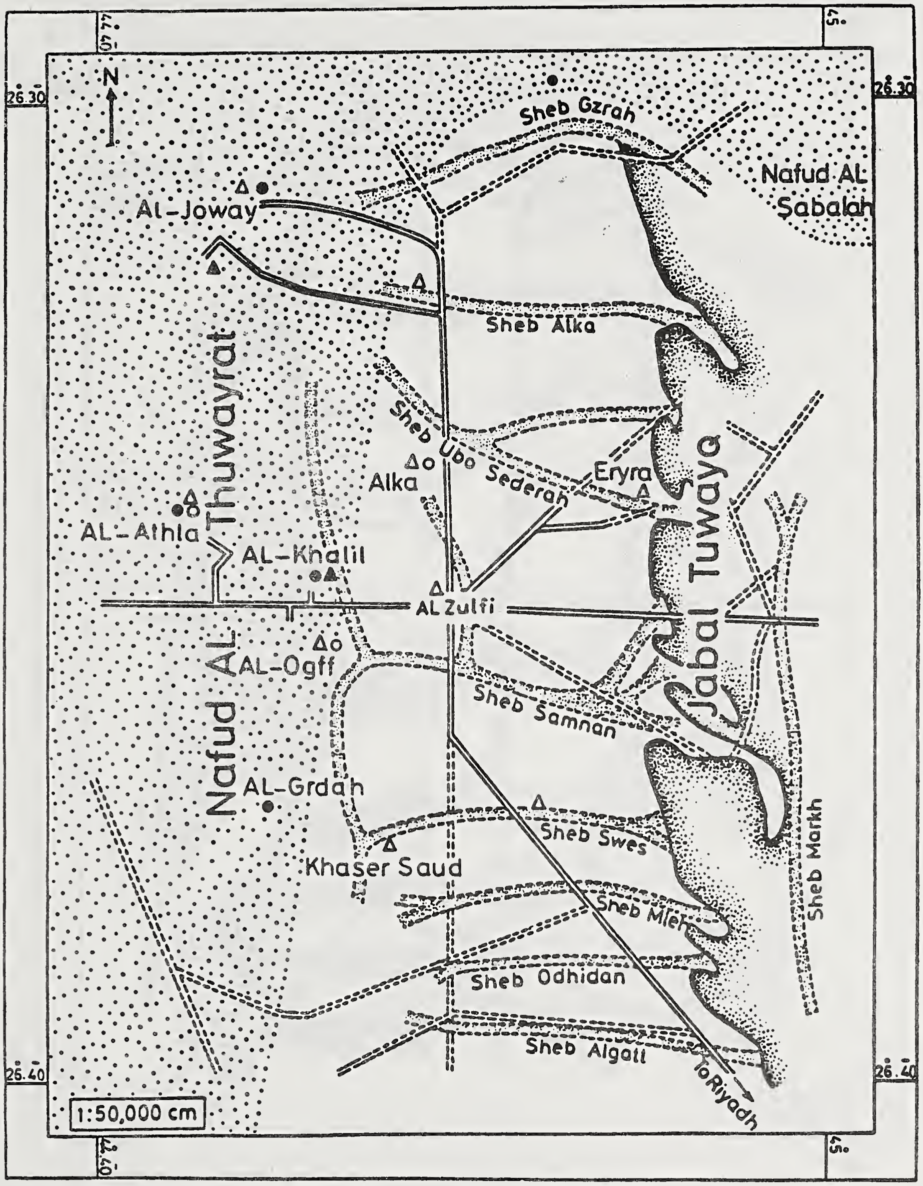

Fig. 7. Distribution of family Scincidae in Al-Zulfi area:
(o) *C. ocellatus*; (Δ) *M. brevicollis*;
(●) *S. m. mitranus*; (▲) *S. s. conirostris*.

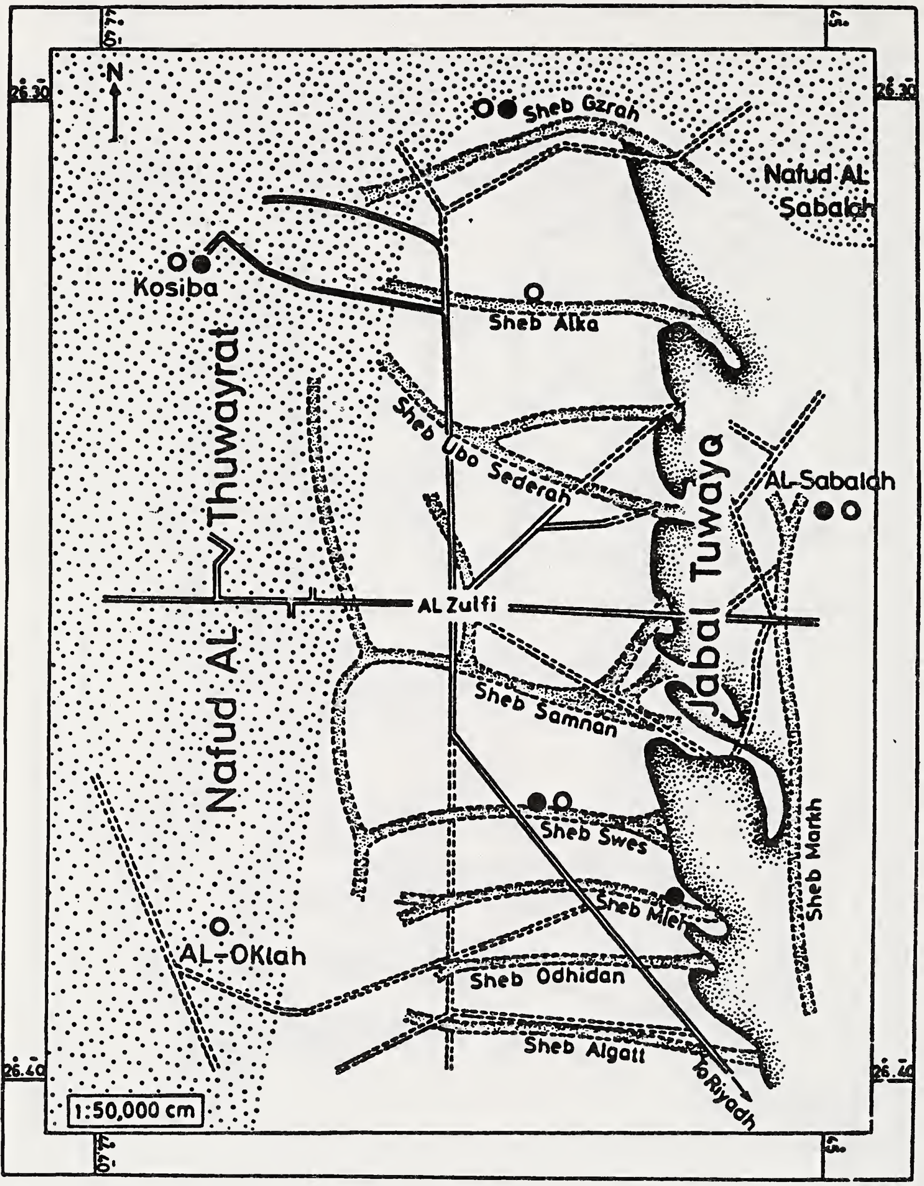

Fig. 8. Distribution of the family Trogonophidae and the family Varanidae in Al-Zulfi area: (o) D. zarudnyi; (●) V. g. griseus.

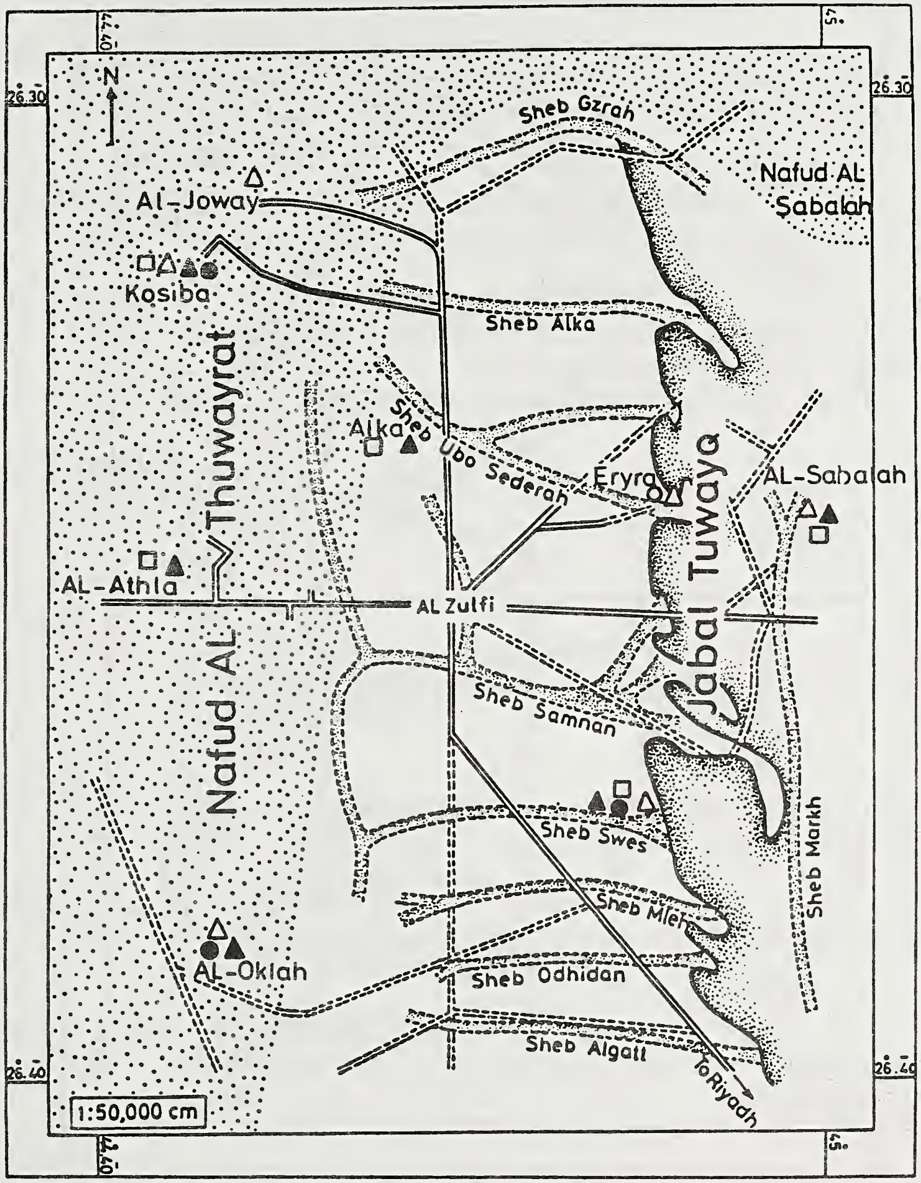

Fig. 9. Distribtuion of the family Colubridae in Al-Zulfi area:
(o) C. elegantissimus; (●) L. d. arabicus;
(▲) M. moilensis; (△) P. s. schokari;
(□) S. d. cliffordi.

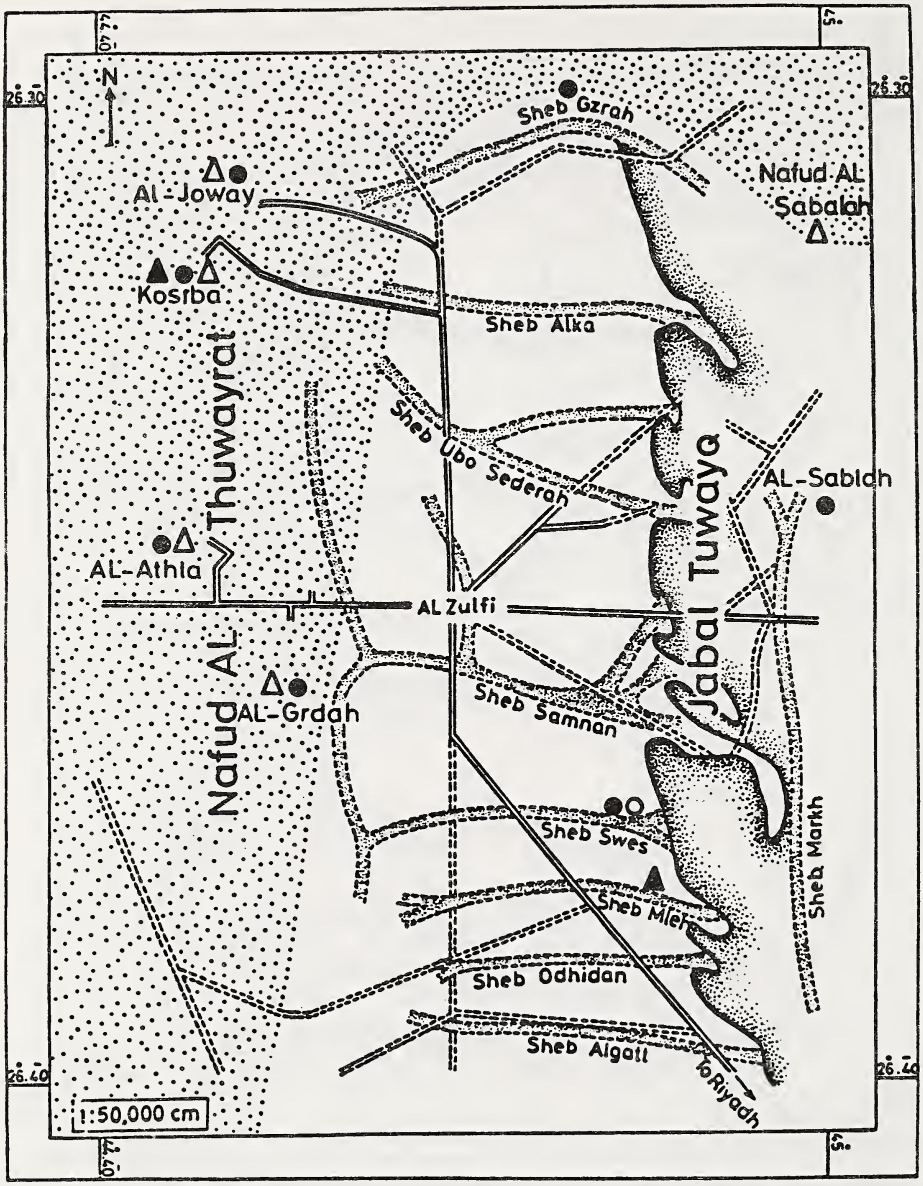

Fig. 10. Distribution of the families : Atractaspididae, boidae, Elapidae and Viperidae in Al-Zulfi area:

(▲) A. m. engaddensis; (Δ) E. jayakari;

(o) W. aegyptia; (●) C. c. gasperetti

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RELOCATION OF STRUCK PREY BY VENOMOID (VENOM-LESS) RATTLESNAKES, *CROTALUS VIRIDIS OREGANUS*

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Abstract

After a rodent is struck and released by a rattlesnake (*Crotalus viridis oreganus*), the rattlesnake follows the trail of the envenomated mouse to recover the dispatched prey. If given a choice, rattlesnakes preferentially follow trails left by rodents they envenomate over trails left by unstruck mice. This has lead to the hypothesis that rattlesnake venom might place or elicit a necessary scent on envenomated prey making such discrimination of trails possible. However, our results, reported here, indicate that even venomoid rattlesnakes, those in which the venom duct was ligated to prevent venom release, still show preference for the trails made by struck (but no venom) mice over the trails left by unstruck mice. Consequently, injection of venom is apparently not necessary for rattlesnakes to be able to distinguish between trails of struck and unstruck mice.

Following the predatory strike, a rattlesnake usually releases adult rodent prey (Klauber, 1956), which dashes a short distance (Hayes & Galusha, 1984), and dies. Soon thereafter, the snake begins efforts to relocate this dispatched prey (Fitch, 1949). The strike itself is important in initiating the poststrike searching and in initiating a sustained high rate of tongue flicking (Chiszar *et al.*, 1977; Chiszar *et al.*, 1978). Tongue flicks are thought to help guide the rattlesnake along the odoriferous trail left by the envenomated rodent (Dullemeijer, 1961; Duvall *et al.*, 1978; Duvall *et al.*, 1980). Rattlesnakes in search of prey during this poststrike searching preferentially follow the trail of envenomated mice rather than alternative trails produced by non-envenomated mice (Chiszar *et al.*, 1983). This has led to the suggestion that chemical components of the rattlesnake venom may function to enhance the perceptibility of the trail left by the envenomated prey (Chiszar *et al.*, 1983).

The purpose of our study was to test whether in the absence of venom and thus in the absence of any chemical(s) it might contain, rattlesnakes could, during poststrike searching, still distinguish between trails of struck and unstruck mice.

Methods

General Procedures:

The test arena was an open and square (130 cm/side) corral, made of pressed fiberglass panels rested 20 cm above the floor on metal supports. Temperature in the arena room ranged between 25 and 30°C during trials. For each trial, new butcher paper was placed on the arena floor and covered a darkened Y-shaped image or maze sketched on the arena floor beneath whose faint outline could be seen through the butcher paper. The base of the Y-maze measured 60 cm with 45 cm branches arranged at a 90 degree angle to each other. Prior to each trial, a snake was placed in a plywood holding box, (30 wide x 60 x 60 cm) with a clear plastic closing top, placed at the base of the Y-maze. A small hole (6 cm dia) at the front, floor of the box opened to the beginning base of the Y-maze. A removeable wooden chute was fitted to the outside, front of this holding box. The preweighed mouse was gently slid down this chute into the holding box with the snake. Once the mouse was struck, a string tied to its tail allowed retrieval, and the chute was removed and replaced by an opaque temporary door. Next the mouse scent trail was laid along the Y-maze as determined by protocols of each experiment. In general, each mouse was hand-held by the nape of the neck and base of the tail, and was pushed along predetermined paths smoothly and in one single pass with their ventral surface against the butcher paper lining the arena floor. Once struck, mice were immediately (within 20 sec) used to make the trail called for by the protocol. This meant that as they were being pushed to make the trail, they were either dead or exhibiting convulsive reflex running (see Kardong, 1986 for discussion of symptoms). After the trail was laid, the mouse was removed from the arena. The temporary door guarding the 6 cm hole was then removed, and the experimenter retreated out of view. All subsequent movements of the snake were observed via a VHS video system through a camera suspended above the arena. The position of the envenomated mouse was randomly altered between the two branches of the Y-maze. A snake was considered to be following a scent trail if its head remained within 10 cm of either side of the scent trail. A trial was ended when a snake either reached the end of a trail, defined as "choice", or failed to follow or to remain close (± 10 cm) to either trail for 5 minutes, defined as "no choice". "Choice" and "no choice" trailing behaviors were usually quite distinct. Snakes making a "choice" usually promptly departed the holding cage and moved decidedly along one scent trail. "No choice" behavior was characterized by snakes moving with no apparent direction away from the trail.

All rattlesnakes were northern Pacific rattlesnakes, *Crotalus viridis oreganus*, captured in the wild within Whitman County, Washington and successfully fed rodents (dead) for varying lengths of time (1 to 3 years) prior to these experiments. Each of 30 snakes was used in one but never more than five trials, except for the five venomoid snakes. Of the venomoid snakes three accounted for about 75% of the data (25% each). All mice were white laboratory mice (Balb/c) raised under proper federal regulations. In a particular trial, all mice were from the same litter. Safety procedures generally followed those of Gans and Taub (1964).

Experimental Protocols

Experiment 1 — Envenomated vs control mice. Experiment 1 was the combination of two separate protocols using 13 (1A) and 14 (1B) rattlesnakes. In both experiments, the snake was faced with a choice between a trail laid down by an envenomated mouse it struck and an unstruck control mouse. In the first protocol (1A), control and envenomated mice used to produce choice trails were different individuals; in the second protocol (1B), control and envenomated mice were the same individual in each trial. In the first protocol (1A), the trail of the envenomated mouse originated near the small hole in the holding box and was laid out down the 60 cm base of the Y-maze and along one of the two 45 cm branches. The trail of the unstruck mouse paralleled that of the struck mouse along the base of the Y-maze but diverged along the opposite branch of the Y-maze. The two trails on the base of the Y-maze were drawn out on separate sides of a meter stick on edge, which was removed after both trails had been laid.

In the second protocol (1B), laying the two trails was the same except the mouse (alive) was first used to lay out an unstruck trail along the 60 cm base and out one of the branches of the Y-maze, then this same mouse was place in the holding box containing the rattlesnake and struck. Now envenomated, this same mouse was again used to lay out an envenomated trail down the base and out the opposite branch of the Y-maze. Less than two minutes separated laying out of first (unstruck) and second (struck) trails. Fourteen individual snakes were used, no single snake was run in more than three trials.

Experiment 2 — Ages of scent trails. In experiment 2 each trial was run with a single mouse. The mouse was first envenomated as described in experiment 1, and used to lay out a trail along the base and out a branch of the Y-maze. After a three minute latency period, the same envenomated mouse was again used to lay out a second trail along the opposite side of the central meter stick and out the opposite stem of the Y-maze. The door to the snake cage was removed and the snake given the opportunity to follow.

Experiment 3 — Struck (no venom) vs unstruck control mice.

Experiment 3 used venomoid snakes. Under anesthetization (Flurothane), main venom ducts of rattlesnakes (five) were located by a small incision along the upper lip on both sides of the head. Each duct was ligated twice with surgical suture, and then cut between ties. After recovery from surgery, snakes were allowed to strike mice to verify (mice show no venom effects) that the bilateral operations were successful. These five venomoid snakes were drawn from the group of snakes used in the first two experiments. Beginning several days to a week after surgery (and confirmation of successful duct ligation), each snake was run in a trial. A non-venomous trail from an unstruck mouse (alive) was laid along one side of the central meter stick on the base and out one of the branches of the Y-maze. This same mouse was then struck by a venomoid snake inside the holding box and used (alive) again to lay the second trail along the opposite side of the meter stick and opposite stem of the Y-maze. The time between laying the first (non-struck) and second (struck) trail was always under two minutes. Then, the door to the holding box was removed and the venomoid snake was allowed to follow.

Results

Rattlesnakes usually made a "choice" of one of the two scent trails in most of the experiments as follows: Experiment 1A, 47% (14/30); Experiment 1B, 74% (26/35); Experiment 2, 62% (20/32); and Experiment 3, 53% (25/47). In experiment 1, the rattlesnakes making a choice usually chose the trail of the experimental (envenomated) mouse regardless of whether that mouse was different from (1A) or the same mouse (1B) used to make the control trail (x^2, $p<.001$, 12.1 n=40). However, as tested in Experiment 2, the three minute difference in age of the two trails did not result in a significant difference in choice of one over the other ($P>.05$). Experiment 3 indicates that rattlesnakes making a choice, chose significantly more often ($x^2\cdot$ $p<.01$, 6.635) the scent trail laid down by the mouse they struck than the trail laid down by the control mouse. This tendency to follow the trail of the struck mouse emerged despite the fact that these snakes were venomoid and delivered no venom during the preceding strike.

Discussion

Our experiments confirm (Chiszar *et al.*, 1983) that individual rattlesnakes can discriminate between mice they strike and those they do not strike, and that during post-strike trailing they preferentially follow the trail of the mouse they struck. However, our results (Experiment 3) indicate that this preference is not dependent upon the prior delivery of venom. Since the contingency Table II (2 x 2) shows no significant difference between experiments 1 and 3, we conclude that deletion of venom had no effect on the basic pattern of these choices. Although our protocol in Experiment 3 required that the trail of the struck mouse be laid down after the trail of the control (the same mouse), the introduced time lag between these two trails does not confound the results, because Experiment 2 demonstrated that this variable had no effect. We thus interpret the preference of venomoid rattlesnakes for trails of mice they struck as related to the preceding strike itself and not to differences in ages of the scent trails.

This leads us to conclude that the ability of rattlesnakes to distinguish the trail of mice they struck from other trails does not require the injection of venom. Certainly, if venom is injected it could enhance the perceptibility of the trail left by the envenomated mouse as it scampered off. But, our results indicate that even in the absence of venom, there apparently remain enough salient cues placed on or produced by the struck mouse that its trail can be distinguished from trails of other non-struck mice.

We also wish to draw attention to the number of times the rattlesnakes made "no choice" (followed the trail of neither the control nor experimental mouse). Somewhat understandably, a few previous studies have gathered data from "good feeders", those snakes that in pretesting proved to regularly tolerate the experimental protocol and follow or respond dependably to presented choices. Certainly snakes scoring "no choice" may do so because they are insufficiently acclimated to the test arena. However, we suggest that these "no choices" may, in part, be a consequence of the elimination of alternative trailing cues. Studies that search for cues used by rattlesnakes during trailing have perhaps tended to look for just one principal cue (e.g. venom odor) and demonstrate its single importance. We wish to emphasize that a struck and envenomated mouse may carry away many cues (chemical, thermal, visual, etc.), and even among the chemical cues several different odors may be available to the trailing snake. Under such conditions, the rattlesnake may initially depend upon an ordered suite of these cues using them collectively to recover the mouse it struck, This set of cues could be used by the snake under natural conditions in some priority order or upon the basis of availability. However, under experimental conditions, only a few cues are made available. Thus, when venom is injected its effect on prey odor may be used preferentially, but when venom is not injected, the snake may shift to secondary or alternative cues to track struck prey. Thus, we wish to propose that the "no choices" exhibited in some of our trails result (at least in part) from the denial of priority cues (e.g., no venom) or the conflict of cues (e.g., same mouse, Experiment 1B). If this trailing behavior is based upon a neurosensory mechanism that ranks cues by some priority, then under experimental conditions we may inadvertently withhold an expected cue and upset this complex choice system enough to prevent the rattlesnake from initiating any choice.

Therefore, these "no choices" may be, in part, the result of disruptions in the fragile complexity of the behavioral basis for trailing struck prey. This would mean that the cues detected and the behavioral system to sort them might be much more complex than has been previously suspected.

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Table 1. Rattlesnake Choices Between Traits of Unstruck (Control) and Struck (Experimental) Mice.

CHOICE			NO CHOICE
	Control	Experimental	
Experiment 1A	2*	12*	16
1B	7*	19*	9
Subtotal	9***	31***	24
Experiment 2	12+	8+	12
Experiment 3	5**	20**	22

*p<.05; **p<.01; *** p<.001: + Not significant, p>.05

Table 2. Comparison of Experiment 1 and Experiment 3.

	Control	Experimental
Experiment 1	9	31
Experiment 3	5	20

Chi Square = .057 (NS), p± 1.96 = (0.6856, 0.8836)

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A NOTE ON DEFENSIVE BEHAVIOR IN THE NEW MEXICO GARTER SNAKE

Head hiding is a common defensive behavior in colubrid snakes, but has not been reported in most species of *Thamnophis* (Hayes and Baker 1986. SSAR Herpetol. Rev. 17(1): 22-23). This note describes the behavior in three specimens of the New Mexico garter snake (*Thamnophis sirtalis dorsalis*) from the Rio Grande Valley of north-central New Mexico.

On 19 September 1989, a male (615 mm snout-vent length [SVL]) was collected on a paved road approximately 5 km SW of Isleta, Bernalillo Co., at 2115 h (after nightfall). Air and road surface temperatures at the time were 20 and 21 deg C, respectively. The snake was motionless in a crawling position when encountered, and when touched it readily assumed an irregular coil with its head beneath a loop of the body. When turned upside down, the snake quickly righted itself and reassumed the posture. It remained upside down when turned over a second time. The snake was also tested for defensive behavior several times while in captivity. When placed on the ground and prodded, it usually attempted to escape and would struggle, defecate, and expel the contents of the cloacal sac when restrained. The head-hiding posture usually was assumed after 10 s or less of harassment, and usually was maintained for at least 1 min. Tail movement was not often exhibited and did not appear to be a typical element of this behavior. In addition, a motionless, uncoiled (or loosely-coiled) posture without head hiding was occasionally elicited by prodding or restraining the snake. The action was superficially similar to death-feigning, but without head-cocking, eye-rotation, or other features usually associated with this behavior (Gehlbach 1970. Herpetologica 26(1): 24-34).

Two other specimens (720 and 519 mm SVL) were collected the same evening, also after nightfall, at a small pond in Los Lunas, Valencia Co. (approximately 5 km to the S of the first locality), and were also tested for defensive behavior while in captivity. Both readily displayed head hiding when tested within 1 h of capture, but after several days in captivity more typical defensive behavior (i.e., struggling when restrained, expulsion of cloacal sac contents, aggressive gaping) was usually displayed after prolonged (> 10 s) harassment. Behavioral differences in these three specimens may reflect heritable variation within a population, as has been reported for defensive responses in *T. radix* (Arnold and Bennett 1984. Anim. Behav. 32(4): 1108-1118), or behavioral variability related to environmental parameters such as temperature, daylight conditions, or even substrate. Additional controlled tests are needed to determine what factors are involved in eliciting differential behavior in individual snakes.

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PARTIAL ALBINISM IN A NEW MEXICO POPULATION OF *BUFO WOODHOUSEI*

Albinistic specimens of Woodhouse's toad (*Bufo woodhousei*) have been reported from several locations in the eastern and southern parts of the species' range (Hensley 1959. Publ. Mus. Mich. State Univ. 1(4): 133-159; Dyrkacz 1981. SSAR Herpetol. Circ. (11): 1-32). This note documents an occurrence of partial albinism in a north-central New Mexico population.

During late June and early July 1988, eight amelanistic tadpoles were collected from a 100 m section of a shallow flood control ditch in the Rio Grande floodplain at Albuquerque, Bernalillo Co. (T11N, R2E, Sec. 25). Amelanistic specimens were collected among normally-pigmented conspecific tadpoles of the same developmental stage (average total length of all tadpoles was 31 mm). Based upon cursory observation, abnormally-pigmented tadpoles constituted less than 1% of all *B. woodhousei* tadpoles present in the 100 m of ditch.

Color notes were taken from live tadpoles and from several amelanistic and normally-pigmented juveniles which metamorphosed from captive larvae. Amelanistic tadpoles and juveniles were yellowish-orange dorsally in life, becoming translucent white in overall coloration following preservation in 10% formalin. Dorsal tubercles were reddish-orange on both normal and amelanistic juveniles, and no color pattern differences were apparent other than the presence or absence of melanophores. Developmental rates appeared to be the same for the two color forms, and body size at metamorphosis was equivalent in captive specimens. No amelanistic juveniles were found at the location in late summer 1988, and only normally-pigmented tadpoles were found during the 1989 breeding season.

Specimens are deposited in the Museum of Southwestern Biology, University of New Mexico (MSB 50457). I thank R. D. Jennings for verifying species identification and Beth O'Leary for assistance with this note.

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MAXIMUM SIZES OF MORELET'S AND AMERICAN CROCODILES

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Abstract

Although *Crocodylus acutus* (Cuvier) is invariably regarded as reaching a much greater size than *C. moreleti* (Duméril and Bibron), the present record length of the latter species (4.16 m = 13.64 ft) is within the range of fully mature, senile examples of *C. acutus* (4.83 m = 15.84 ft), although the maximum verifiable length of the latter species is 6.25 m (20.5 ft).

The maximum length of *Crocodylus moreleti* has always been regarded as much less than that of *C. acutus*. Schmidt (1924), in his seminal revival of the species, based on hundreds of animals observed, saw none even as much as two meters (6.56 ft) long, and even as late as 1971 (Neill, 1971: 360) "8 ft" (2.44 m) was regarded as an "acceptable" maximum. The currently accepted maximum is 3.5 m (10.65 ft), based on Alvarez del Toro's calculation (1974: 32) from a skull; the largest whole specimen ever recorded is one reported in the same work, at 3 m (9.84 ft). Thus 3-3.5 m is cited as the maximum in recent works (e.g., Ross, 1987; Ross and Magnusson, 1989: 65). No intact individuals have been recorded measuring more than 3 m in total length.

Surprisingly, therefore, two of us (GPH, ARR) have observed several populations of *C. moreleti* in southern Veracruz in which individuals more than three meters in total length are not rare. We caught five at Arroyo Agrio (on the northwestern edge of Lake Catemaco) measuring more than three meters; the two largest reached 3.76 m (12.34 ft) and 4.16 m (13.64 ft). The latter individual (the only male of the five) had been marauding a popular tourist area (Nanciyaga), hence was transferred to Laguna de Nixtamalapan, a crocodile breeding area maintained jointly under the auspices of the Universidad Nacional Autónoma de México (UNAM) and the Secretaria de Desarrolo Urbano y Ecología (SEDUE). Other crocodiles of comparable large size were observed at Laguna de Macay (an extensive swamp) near the municipality of Isla). In addition we have an unconfirmed oral report of a large specimen named "papillón" that lived for several years at La Venta, a "centro de convivencia" (housing development) in Villahermosa, Tabasco.

Certainly, therefore, *C. moreleti* reaches a total length of 4.16 m, may well reach 4.5 (14.75 ft), and not uncommonly exceeds 3 m. It is likely that intense human predation over many decades has been responsible for removal of most of the largest examples of the species, which has at best a very limited geographic range; as a result, the erroneous impression arose that the species is small. Human exploitation persists except where the animals are protected, nearly exterminating a species once very common. "In 1923 K. P. Schmidt saw hundreds (all small)...from the causeway that links Belize with...higher ground. But by the time I first visited British Honduras, in 1959, crocodiles no longer existed anywhere near the causeway, even though the swamps themselves remained...Several trips, to all districts of British Honduras and to nearby parts of Guatemala and Mexico, revealed Morelet's crocodile to have been killed off almost everywhere..." (Neill, 1971: 360-1).

At about 4.25 m in maximum length, *C. moreleti* is about as large as most other species of the genus, rather than being one of the smallest (Ross and Magnusson, 1989). It is not as much smaller than *C. acutus* as has been commonly thought, particularly in view of such impressive maxima as 7.7 m (25.26 ft) in print (Wermuth and Fuchs, 1978: 80), as opposed to 2.5 m (8.2 ft) cited in the same work for *C. moreleti*. On the contrary, 6.25 m (20.5 ft) (Alvarez del Toro, 1974: 14-15) is the greatest confirmed length for the species, as accepted by most recent authorities (e.g. Ross and Magnusson, 1989: 65). In Florida, the largest recorded measured "15 feet 2 inches in length, with an estimated 6 inches missing from the end of its tail" (Neill, 1971: 339). Another captured at Lantana, Florida, on Biscayne Bay, measured 14 feet in total length when it died, but "was showing signs of senility" and "had ceased growing" (loc. cit). There is little reason to think that *C. acutus* ever much exceeds Alvarez del Toro's record of 6.25 m. Neill (1971: 339) noted that "The maximum length of the species is commonly given as 23 feet, but this figure stems from an old account that was never amenable to verification."

Nevertheless, human persecution has haunted *C. acutus* much as it has *C. moreleti*. In 1936 one of us (HMS) spent several weeks at Balchacaj, at the mouth of Rio Chumpán where it opens into Laguna de Términos. Every day several huge crocodiles, presumably *C. acutus* (although skulls of both *C. acutus* and *C. moreleti* were taken there fide Smith, 1938: 21-22) were seen floating down the river. Today (Alvarez del Toro, 1973: 15) such sizes (3 m = 9.84 ft) are rarely seen. Likewise in Florida, Kushlan and Mazzotti (1989: 17) found in their intensive study that sizes were appreciably smaller in 1977-82 than in the earlier years reported by Neill (1971); only one female measured 3 m or more (3.08 m = 10.1 ft), and three males reached that length, with a maximum of 3.95 m (12.95 ft). In Cuba, Varona (1987) reported that the species is approaching extermination and that individuals 4 m (13.12 ft) are rare.

Current knowledge indicates, therefore, that C. *moreleti* reaches a larger size than formerly thought - a size nearly comparable with that of C. *acutus*.

Acknowledgments

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SCELOPORUS TORQUATUS MADRENSIS IN SAN LUIS POTOSI MEXICO

Sceloporus torquatus madrensis, the "dwarf race," is characterized by small adult size (ca. 90-95 mm SVL, compared with 100+ in other races), relatively long forelimb and hindlimb, and somewhat narrow head. Previously the subspecies has been known from only Rancho del Cielo area, Tamaulipas, Mexico (Olson, 1986, Bull. Maryland Herp. Soc., 1990, Bull. Chicago Herp. Soc.), but recent review of a small collection from San Luis Potosi has helped to understand its range better and to clarify relationships to other races.

Nineteen specimens from 6 mi. W Ahuacatlán, S.L.P. (a village 6 km S Xilitla) exhibit characters referable to *S. t. madrensis.*

This subspecies, as is true of populations of the lineage, represents inhabitants of moderately high (ca. 1800 - 2300 m) elevations in pine-oak association. The present report extends the known range of *S. t. madrensis* some 150 km southward.

	X	range	N
Adult SVL	92.5 mm	87-97	8
head length/ head breadth	.93	.91-.96	4
hind limb length trunk length	.48	.46-.53	6
dorsals	27.0	25-30	17
ventrals	35.0	32-38	5
femoral pores (per side)	14.9	12-17	17

Fig. 1: A table of data from specimens of *S. t. madrensis* from 6 mi. W Ahuacatlán, S.L.P.

Presently it appears that intergradation between *S. t. madrensis* and *S. t. torquatus* occurs in the Ahuacatlán area. However, there is more pronounced influence of *madrensis* in this sample, and I regard the population to represent that race.

Thanks are due Dr. Douglas Rossman, Louisiana State Museum of Natural Science, Baton Rouge, for loan of specimens. Catalogue numbers are: LSUMZ 4233-4235, 4887-4901.

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Major papers are those over 5 pages (double spaced, elite type) and must include an abstract. The authors name should be centered under the title, and the address is to follow the Literature Cited. Minor papers are those papers with fewer than 5 pages. Author's name is to be placed at end of paper (see recent issue). For additional information see *Style Manual for Biological Journals* (1964), American Institute of Biological Sciences, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016.

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The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May—August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

Volume 27 Number 2 June 1991

MORPHOLOGICAL VARIATION AND SYSTEMATICS OF THE GREEN ANOLE, *ANOLIS CAROLINENSIS* (REPTILIA: IGUANIDAE)

Thomas Vance

Abstract

This paper reports on the morphological variation of the green anole, *Anolis carolinensis*. Scutellation features, head shapes, 4th hind toe widths and lamellar counts, and color patterns were observed and recorded which result in the description of a subspecies from Florida. In addition, the problematical systematic history of this species is reviewed and a neotype is designated in lieu of the absence of a holotype. Finally, the study of numerous preserved specimens provide additional county records for several of the Gulf Coastal states.

Introduction

The green anole or chameleon of southeastern and south-central United States is a well known reptile to most herpetologists and pet fanciers. This is due to its abundant occurrence within its wide range as well as its captive adaptability. It has been studied both in field and laboratory for over 200 years, resulting in publication of a voluminous amount of literature (Vance, in press). Few reptiles of the United States have been as intensely studied as *Anolis carolinensis*.

The currently understood descriptive information of *A. carolinensis* may be summarized in the following sentences. In adults the head is long, wedge shaped, flattened ventrally and dorsally and is covered by small heavily keeled scales. In juveniles the head is not as long nor is it as wedge shaped nor dorsally flattened. Females tend to show an intermediate variation between adult males and juveniles. The head has marked indications of a frontal and canthal ridge and has somewhat enlarged supraocular scales. The interparietal scale (occipital scale of early authors) is nearly the size of the ovular ear opening. Scales on the tip of the snout follow the basic pattern of the species complex as defined by Ruibal and Williams (1961) among others. The mental scale is divided. The dorsals are granular with blunt keels which may be seen only with aid of a lens.

Ventrals are also granular and are usually slightly more keeled and larger than dorsals, but an exception has been noted by Duellman and

Schwartz (1958) (see Taxonomic Variability). Except for the first toe of the forefoot, digits are expanded while the underside contains transverse rows of lamellae that have microscopic hooklets used for climbing. Femoral pores are absent. Males have two enlarged postanal scales and a highly functionable dewlap, whereas females and juveniles do not exhibit as functional a dewlap; however, one may be coaxed into expanding it by picking up the animal by the base of the tail and holding it head downward. When the dewlap is expanded, scales are separated by colored skin. Some scales on the calf of the hind leg tend to be enlarged and keeled. Tail scales sometimes have inconspicuous rings of larger scales, but these rings represent external evidence of breakage planes. The tail is round in cross section and the scales are keeled, but may vary in size. When the anole is not excited, a nuchal crest is absent. A caudal crest is never present.

Material and Methods

In order to gain an understanding of *A. carolinensis* a total of 21 morphological characters were recorded of which 12 were found to be of diagnostic use which are based on 897 specimens studied (Figs. 1 & 3). The number of canthal scales counted include those which come into contact with the loreals; the number of scales counted on the frontal ridge include the supraorbital semicircles and extend to the postrostral; the number of scales counted between the canthal and frontal ridge extend posteriorly on the nasal scale to the anterior aspect of the orbit; the number of scales counted between the frontal ridges extend from the junction of the anterior frontal ridge scales to the midpart between the supraorbital semicircles; the number of scales counted around the nostril are the granules surrounding it; the number of loreal scales counted include all of the loreals and the number of rows counted are those of the highest number between the canthal ridge and upper labials; the supraocular scales are those immediately superior to the orbits; the temporal scales between the eye and ear opening are usually represented by an area of dark coloration; the number of the postanal scales are a typical male characteristic and are located posteriorly of the vent; the interparietal and ear openings are measured according to their longest length and compared; the number of digital lamellae of the 4th toe of the hind foot are those which begin at the junction of the foot and toe and extend to the toenail; the amount of digital expansion of the 4th toe of the hind foot is the amount in relation to the length of that toe; the axillary spot is a dark blotch usually surrounded by one row of light scales above the foreleg and is commonly seen on many preserved specimens; the snout shape is based on the angle of the anterior portion as compared with the posterior of the head; the head length is measured in millimeters from the tip of the snout to the posterior suture of the interparietal; the head width is measured across the center of the eyes; and the body length is the distance from the tip of the snout to the vent.

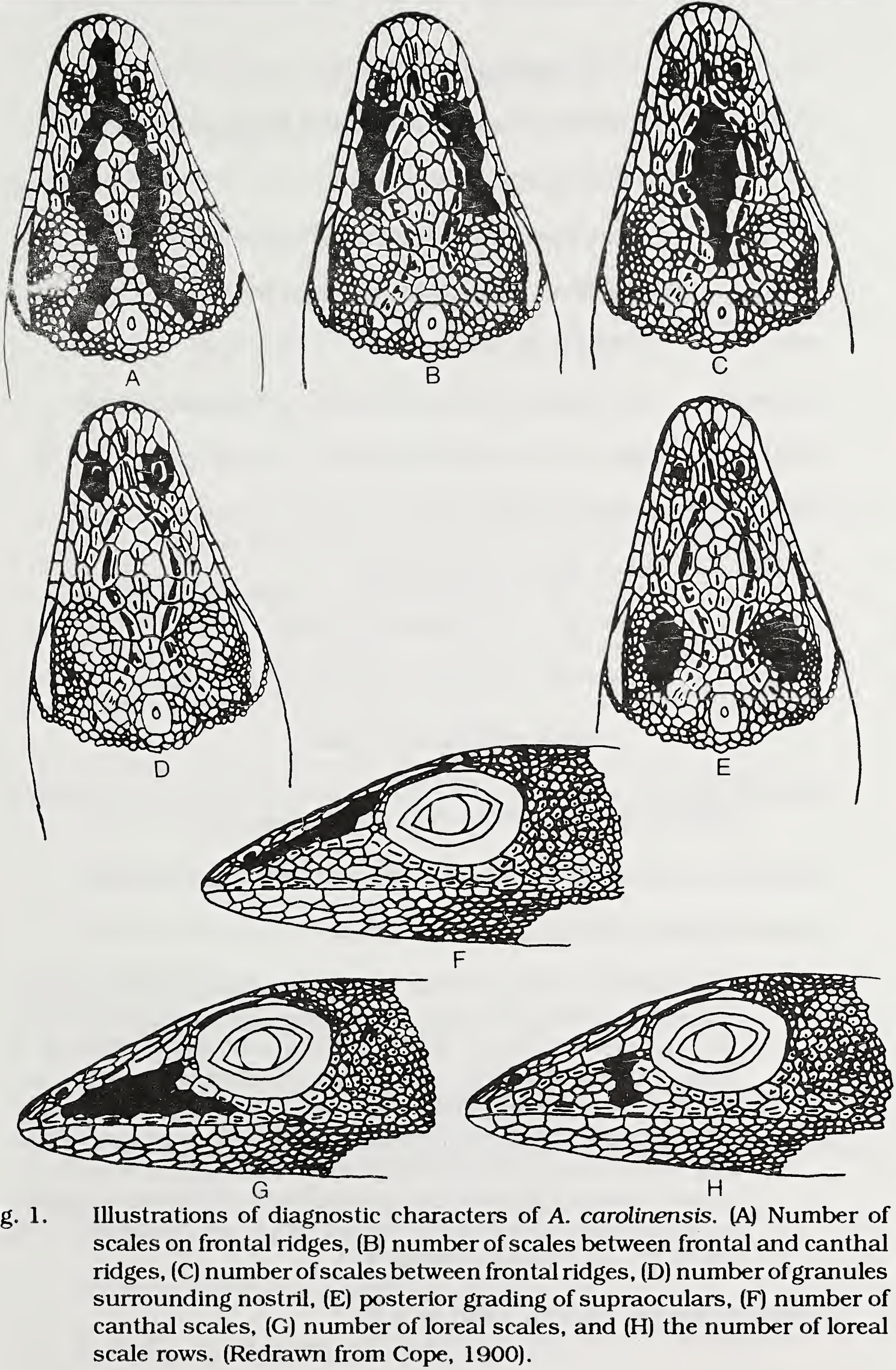

Fig. 1. Illustrations of diagnostic characters of *A. carolinensis*. (A) Number of scales on frontal ridges, (B) number of scales between frontal and canthal ridges, (C) number of scales between frontal ridges, (D) number of granules surrounding nostril, (E) posterior grading of supraoculars, (F) number of canthal scales, (G) number of loreal scales, and (H) the number of loreal scale rows. (Redrawn from Cope, 1900).

MUSEUM ACRONYMS

AMNH	American Museum of Natural History
CR	Charleston Museum
DMNH	Dallas Museum of Natural History
FMNH	Field Museum of Natural History
FSM	Florida State Museum
LACMNH	Los Angeles County Museum of Natural History
MPM	Milwaukee Public Museum
NC	Navarro College
TMM	Texas Memorial Museum
UAM	University of Arkansas Museum
UCMZ	University of California Museum of Zoology

Anolis carolinensis Voigt

Lacerta Plica, Castiglioni, 1770 [inference by Dundee and Ewan, 1979; misidentified as *Plica plica* Linnaeus].

Iguana strumosa?, Brongniart, 1805, p. 33 [*nomen dubium*].

Anolis bullaris, Harlan, 1827, p. 16 [Part].

Anolius carolinensis, Voigt, 1832, p. 71, [Type specimen undesignated and presumed to be lost (see Nomenclatural History) or non existent (Brown, 1950). CR862 is designated as a neotype. Type Locality: Not present in original publication, but Stejneger and Barbour (1917, et seq.) assigned the locale as "Carolina"; however, Schmidt (1953) further restricted the type locality to "Charleston, South Carolina" (see Nomenclatural History). The current designated neotype was collected in Charleston County, South Carolina, on September 29, 1929, by an unknown collector.]

Anolis strumosa, Harlan, 1835, p. 143.

Anolis Carolinensis, Dumeril and Bibron, 1837, p. 120 [Part].

Anolis podargicus, Richardson, 1837, p. 200 [Part].

Anolis bimaculatus, Richardson, 1837, p. 200 [Part].

Anolis Carolinensis, Holbrook, 1842, p. 67.

Dactyloa carolinensis, Fitzinger, 1843, p. 68 [Part].

Dactyloa biporcata, Fitzinger, 1843, p. 68 [Part].

Anolis principalis, Gray, 1845, p. 202.

Anolis carolinensis, Baird, 1859, p. 12.

Lacerta bullaris, Troschel, 1868, p. 51 [allocated to *A. carolinensis* by Smith and Smith, 1976, p. L-B-94 (*nomen dubium*)].

A. [nolis] principalis, O'Shaughnessy, 1875, p. 276 [Part].

[Anolis] Lacerta principalis, Garman, 1884, p. 19.

Anolis carolina, Wood, 1898, p. 81.

A. [nolis] carolinensis, Gadow, 1905, p. 212 [Part.}

Uta ornata? Grinnell and Camp, 1917, p. 157 [Part?].

Anolis carolinensis carolinensis, Cook, 1942, p. 8.

Anolis carolinensis [carolinensis], Oliver, 1948, p.13.

Anolis c. [arolinensis] carolinensis, Oliver, 1950, p. 56.

Anolis [carolinensis], Goin, 1958, p. 62.

Anolis sp., Hamilton and Pollack, 1958, p. 25 [sensu stricto].

A. [nolis] c. [arolinensis] carolinensis, Buden and Schwartz, 1968, p. 295.

Anolis caroliniensis, Simon, 1973, p. 48 [lapsus calami].

[Anolis] carolinensis, Williams, 1976, p. 13.

A. [nolis] carolinensis carolinensis, Vance, 1976, p. 113.

Content:

Polytypic, two subspecies are presented herein (see Taxonomic Remarks)

Diagnosis:

Anolis carolinensis is a member of Etheridge's (1960) alpha group of *Anolis* and is a member of the *carolinensis* species group as defined by Ruibal and Williams (1961).

This species differs from all others species of the *carolinensis* group by the presence of 9/9 - 16/15 scales on the frontal ridges inclusive of the supraorbitals; frontal ridges usually 3 scales wide at the widest area between the frontal ridges; 5/5 - 7/7 scales present between frontal and canthal ridges; the number of scales between the frontal ridges vary from 3-21 up to the narrowest area between the supraorbitals; 6/6 - 9/9 of scales surrounding the nostrils; 15/16 - 43/45 loreal scales; first sublabial only in contact with first infralabial; adpressed hind legs fail to reach ear opening; ear opening oval; head shape blunt to sharply pointed east of the Mississippi River and somewhat longer west of the Mississippi River (Figs. 4, 5); frontal ridges not as evident from the lateral aspect; 4th hind toe is dilated one quarter to one half the distance of the toe; 33/32 - 50/50 lamellae present from the junction of the toe and foot to the toe nail. The illustration presented in Cope's (1900) monograph is taken from an individual of an unknown locality, but the geographic variation of the specimens studied indicates that the figured animal was native to the Carolinas or northern Georgia or Alabama.

Distribution:

The general range of *A. carolinensis* has been generally interpreted as from either southeastern Virginia, or northern North Carolina, depending on the authority, southward through Florida and the Keys, westward into the southernmost portion of Texas and through eastern central Texas, and northward into southeastern Oklahoma, the southern half of Arkansas, and southern and southeastern Tennessee (Fig. 2). It has been variously described as inhabiting the Austroriparian, Texan, and eastern Tamaulipan biotic provinces (Conant, 1975; Vance, in press). A complete listing of distributional literature is provided in another report (Vance, in press).

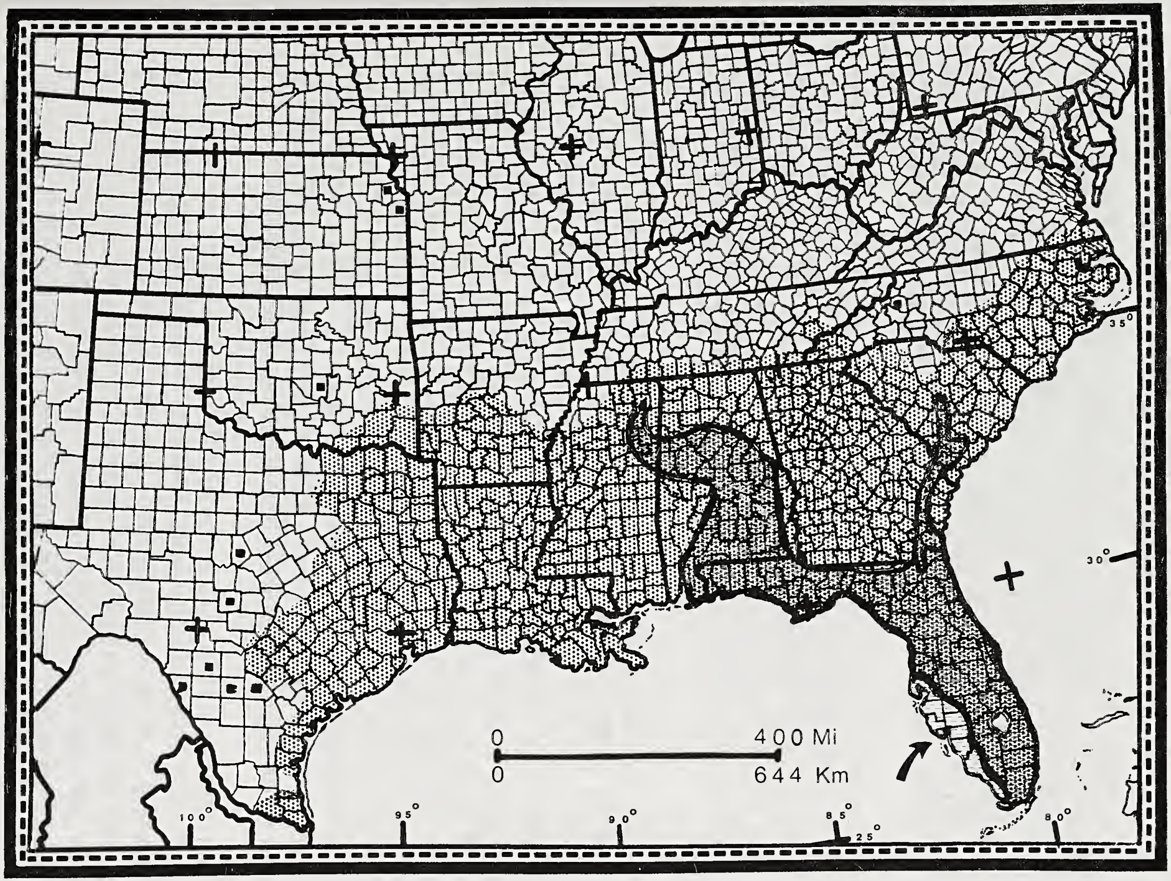

Fig. 2. Generalized and expected distribution of *Anolis carolinensis* in the United States based on literary and observed accounts. The arrow is pointing to the range of *A. c. seminolus* subsp. nov., heavy stippling represents intergradation areas of *A. c. carolinensis* X *A. c. seminolus*. Squares represent records outside of the general range. Crosses indicate areas of latitude and longitude.

Nomenclatural History:

Anolis carolinensis has had a perplexing and often questionable taxonomic history which has caused several problems regarding the correct scientific name, type locality and holotype. Of all the early works on this subject, the first acceptable (to some authors) descriptive account of what could be this taxon was provided by Voigt (1832). In addition, it has been referred to as *A. bullaris*, *A. principalis* and *A. carolinensis*. Unfortunately, this is due to one author basing the usage and authority on another's usage. All in some way have been based on Linnaeus. In spite of this, other early authors attributed the source to Linnaeus, Cuvier, or even Dumeril and Bibron. Some authors have tended to misspell Voigt's name as "Voight."

This species has been well known even from colonial times. The green lizard of Lawson (1709) may have been one of the first accounts of *Anolis carolinensis*. Brickell (1737) provided another account of the species and supplied the first illustration of this animal, but it was poor in quality. Bartram (1791) briefly noticed the lizard while he traversed the southeastern United States.

The actual problem regarding the classification of this taxon began with the publication of Mark Catesby's book "*Natural History of Carolina, Florida and the Bahama Islands...*" which was prepared during the period 1731-1747. He described the size, habits, and color of a lizard of the anoline type and named it *Lacertus viridis carolinensis* or the green lizard and artistically posed it on a shrub. An accompanying engraving depicting a lizard on a shrub was typical of Catesby's illustrations and lacked sufficient detail to be identified as *A. carolinensis*. He also presented another description of an anole, along with an engraving, as *Lacertus viridis jamaicensis*. Lynn and Grant (1940) thought this was *Anolis grahami iodurus*; however, Frick and Stearns (1961) referred it to *A. g. grahami*. Thus, Mark Catesby's work ended the period of pre-Linnaean literature on this subject.

Problems regarding this species scientific name became more acute when Linnaeus (1754, 1758, 1766) published his series of monographs on organism classification. In 1754 he named *Lacerta principalis* and provided a very brief description of it. He said the habitat was "India"; however, in his taxonomically important 10th edition (1766), he stated the habitat of *L. principalis* as "America Meridionali." In the English translation his description is; "Tail subcarinate, crest on the throat very entire; back smooth. Inhabits South America; of an uncertain tribe. Skin very thin; tail jointed, each joint consisting of 5 rings of very thin scales; the last joint but one of the toes broader." He also provided a description of another closely related lizard, "*Lacerta Bullaris*", "Tail round, long; chin pouched. Inhabits Jamaica;

small green gular pouch globular, and retractile, which the animal when terrified is able to inflate." This latter description is important because other authors used this name for mainland *A. carolinensis.* Could this be the *A. jamaicensis* of Catesby? Sherborn (1929) thought *Lacerta principalis* was the earliest name.

The proper application of *A. principalis* or *A. bullaris* have not been determined (Barbour, 1930). These names were used by Gray (1845) and were considered separately, but he assigned *A. chlorocyanus* of Dumeril and Bibron (1837) to synonymy of *A. bullaris.* It is possible that *Lacerta bullaris* may be *Lacerta viridis jamaicensis,* but this is only conjecture. Barbour (1930) placed specimens listed by Gray (1845) in the species *A. chlorocyanus.*

Daudin (1802) is credited with naming the genus *Anolis* and designating *Anolis bullaris* Latreille as the type species. He questionably regarded *carolinensis* as "L'Anolis roquet" from Catesby's work, and he questionably considered *L. principalis* Linnaeus as "L'Anolis bimacule'" which was based on the Jamaican studies of Sloan (1725) (see Ahredfeldt, 1954). Conceivably, *L. bullaris* Linnaeus belongs to a Jamaican form of *Anolis* (Barbour, 1930). Merrem (1820) thought Catesby's green lizard was *A. bullaris* and *L. principalis* Linnaeus as a then currently recognized species, but his references were confused. Thunberg (1823) provided a highly questionable citation of *Lacerta principalis* which was simply in a list of species (Vanzolini, 1977). Wagner (1830) considered Catesby's *L. v. carolinensis* to be *L. principalis* of Linnaeus. He also lumped these two names under the genus *Dactyloa.* Once again, their true designation is not known. The *Anolis Bullaris*' mentioned by Kirby (1832) is not thought to be *A. carolinensis* because of the "reddish" color description. Brief summaries of Daudin (1802), Merrem (1820), and Wagler (1830) are presented by several authorities; however, Harper (1940) and Vanzolini (1977) provided the best herpetological accounts. Frick and Stearns (1961) and Adler (1979), among others, give brief summaries of Mark Catesby's work.

Voigt (1832) is currently credited with formally naming *Anolis carolinensis* and is recognized as the authority by most recent authors. Voigt based this name on Catesby's assignment and also recognized *A. bullaris.* In neither case did he provide type material, and descriptions of both were very brief and inadequate. This was, in part, a translation of Cuvier's "Regne Animal..." (Smith and Smith, 1973) which Vanzolini(1977) briefly discussed. Sherborn (1922) considered Voigt's description the earliest usage of the name and *Lacerta principalis* as the earliest name (Sherborn, 1929).

Dumeril and Bibron (1837) were unconvincing in their argument that *L. principalis* Linnaeus and *A. carolinensis* were the same species. A woodcut illustration of the dorsal aspects of the head of "*A. principalis*" was presented by Dumeril et al. (1870, Atlas), but its features agree with those of *A. porcatus* of Cuba and elsewhere (Vance, 1987). Rhoads (1895) did not accept Dumeril and Bibron's reasons and discarded the Linnaean name. Rhoads also stated that Cuvier did not apply a binomial to this species, leaving Voigt's (1832) name next in line for possible recognition, but Rhoads did recognize Dumeril and Bibron as authorities on *A. carolinensis*.

Stejneger (1904) considered *A. bullaris* as the type species of the genus, but admitted that the species could not be readily placed. He also stated that *A. bullaris* Linnaeus rest on Catesby's illustration and that *A. bullaris* Daudin is also based on Linnaeus.

Dumeril and Bibron (1837) divided *A. bullaris* Daudin into *A. chlorocyanus* and *A. carolinensis*. According to Brown (1908), *A. carolinensis* Dumeril and Bibron rests on Catesby's work and is acceptable only on an "act of faith," but Dumeril et al. (1870-1909) apparently based their report on Linnaeus.

The work of Richardson (1837) proved to be one of utter confusion. He seemed entirely unsure of how this species should be assigned (see annotations).

Much of the above paragraphs have been summarized by Smith et al. (1963). Frick and Stearns (1961) stated, "None of this early group of Catesby's lizards provided the bases for Linnaean names, though his two final efforts, which has pronounced markings, did."

It is in this respect that one author has based usage and authority of this taxon on another author's usage, and these had in some way been based on the work of Linnaeus. Whether or not Linnaeus based his two anoles on Catesby's (1731-1747) book is conjectural. Thus, *A. bullaris*, *A. principalis*, and *A. carolinensis* were used interchangeably as names for a single taxon from the late 1700's through the early 1900's.

Although the type species, as previously stated, has been considered *A. bullaris*, an accurate allocation has never been furnished. Stejneger and Barbour (1917, et seq.) used the combination of "*Anolis bullaris = carolinensis*" as the type species, and this was subsequently followed by Burt and Burt (1933), Cochran (1941), Smith and Taylor (1950), Schmidt (1953), and Stuart (1963). Smith et al. (1963) petitioned the International Commission of Zoological Nomenclature to designated the type species as *Anolis carolinensis* because the *bullaris = carolinensis* posed a conflict. Peters and Donoso-Barros (1970) thought *A. carolinensis* as the type species, thus rejecting Smith et al.'s (1963) proposal, but Williams (1976) suggested *A. carolinensis* as the type species. Stimson and Underwood (1983) accepted Stejneger's (1904) designation of *Lacerta bullaris* Linnaeus (1758) as the type species of *Anolis* genus, and agreed that *L. bullaris* is a *nomen oblitum* and is based on *L. viridis jamaicensis* of Catesby. They also considered *L. v. jamaicensis* to be the same as *A. garmani* and a junior synonym of *L. bullaris* Linnaeus (1758). Stimson and Underwood (1983) did not accept *A. carolinensis* as one of the species presented in the work of Daudin (1802). Savage (1983) supported the proposal of Smith et al. (1963) to fix the type species of *Anolis*, and he counters the proposals of Sabrocky (1983) and Stimson and Underwood (1983). In a reply, Stimson and Underwood (1983) reject Savage's comment. Sabrocky (1983) rejects the proposal of Smith et al. (1963). Finally, the International Commission of Zoological Nomenclature ruled that *Anolis carolinensis* Voigt is to be designated as the type species of *Anolis* Daudin (Bull. Intl. Comm. Zool. Nomencl., 1986, p. 125). The names *Anolis principalis*, *Anolis bullaris*, *Iguana strumosa*, and *Anolis strumosa* should be considered as *nomina dubia*.

The questionable authority of *A. carolinensis* and the questionable type species for *Anolis* genus poses another problem. Stejneger and Barbour (1917, et seq.) stated their *A. carolinensis* type locality to be "Carolina." This may have been due, in part, to Catesby's original work which centered, to some degree, in the Carolinas. Voigt (1832) clearly did not provide a locale; however, this was repeated in all of the checklists that Stejneger and Barbour prepared. Smith (1946) and Brown (1950) followed the type locality provided by Stejneger and Barbour, but Schmidt (1953) restricted, for unknown reasons, the type locality to "Charleston, South Carolina." Thus, restriction of the type locality is arbitrarily Charleston, South Carolina, but due to the apparent absence of a type specimen (Brown, 1950), and due to the lack of knowledge about the collector, the type locality is highly questionable.

Taxonomic Remarks:

A number of closely related species exist, and *A. carolinensis* has often been confused with these various taxa (Cope, 1894; Barbour, 1910, 1928; Oliver, 1948). These other species have since been allocated to their respective status by Ruibal and Williams (1961), Ruibal (1964), Schwartz and Thomas (1975, 1978), and others (Table I).

ORIGINAL NAME	SYNOPTIC NAME	CURRENT NAME
A. principalis brunneus	A. carolinensis brunneus	A. brunneus
A. smaragdinus	A. c. smaragdinus	A. smaragdinus smaragdinus
A. fairchildi	A. c. fairchildi A. s. fairchildi	A. fairchildi
A. carolinensis lerneri	A. c. lerneri	A. s. lerneri
A. porcatus	A. c. porcatus	A. porcatus
A. maynardi	A. c. maynardi	A. maynardi

Table I. Anoles formerly assigned as *Anolis carolinensis*, based on Schwartz and Thomas (1975, 1978) and Etheridge (1960)

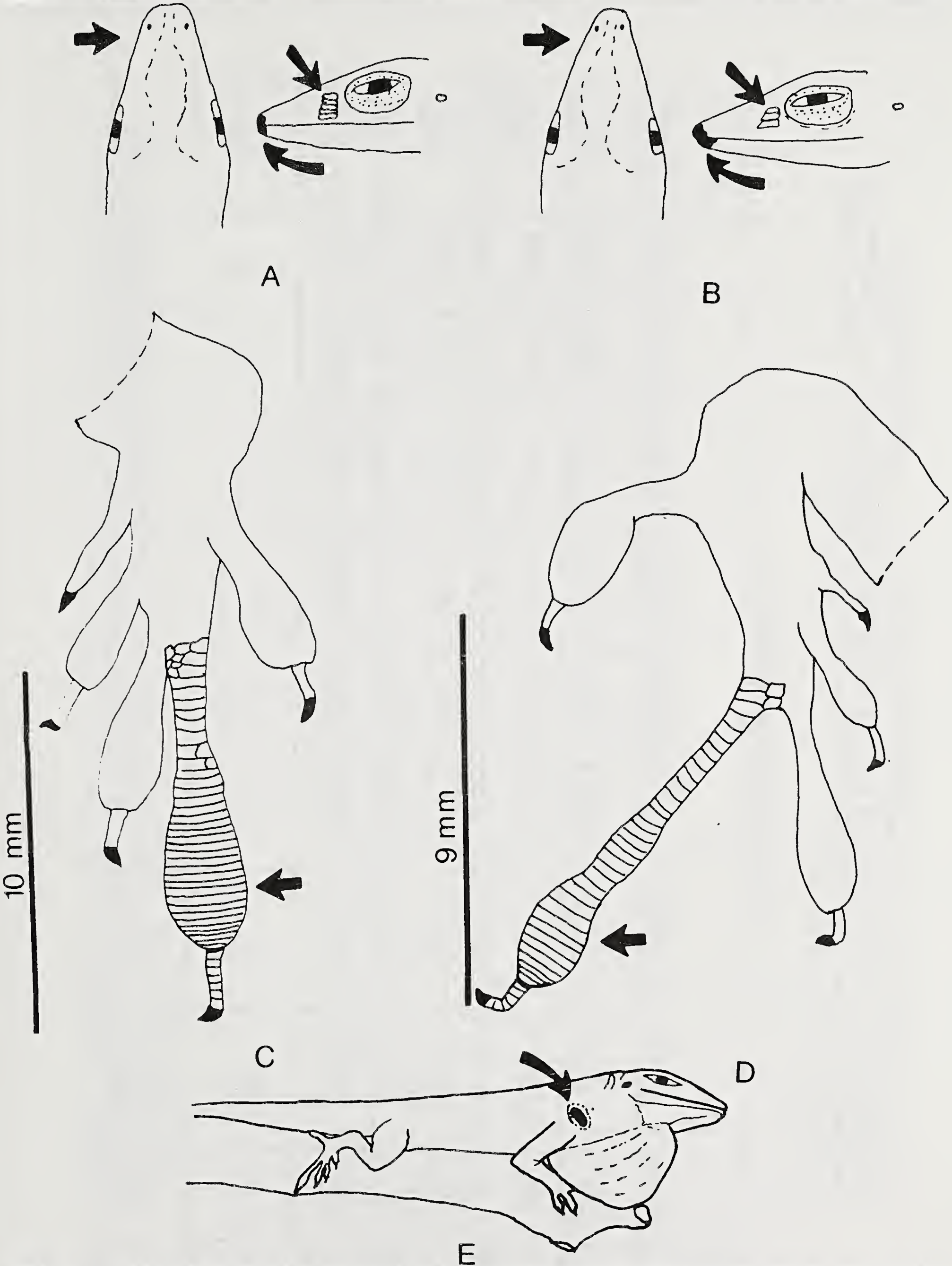

Fig. 3. Morphological variations of *A. carolinensis carolinensis* (UCMVZ 39538) (A and C) and *A. carolinensis seminolus* subsp. nov. (UCMVZ 53793) (B, D, and E) illustrating the shape of the snout, the position of the rostral and mental scales, the number of loreal scales anterior to the eye, width of the 4th toe of the hind foot, and the location of the axillary spot.

Table II. Summary of comparative morphological characteristics of *A. c. carolinensis* and *A. c. seminolus* subsp. nov. Excluded are the data of apparent intergrades of *A. c. carolinensis* X *A. c. seminolus*. * One individual (FSM #56045) has 5/6 loreal scale rows and another (AMNH 21243) has 4/5 loreal scale rows.

	Anolis carolinensis carolinensis									*A. c. seminolus subsp. nov.*
	Georgia	So. Carolina	No. Carolina	Alabama	Mississippi	Tennessee	Louisiana	Arkansas	Texas	Florida
Number of scales on frontal ridge	10/11-15/15	10/10-15/15	10/10-13/14	11/11-14/14	10/13-14/15	12/12	9/9-14/15	11/11-16/15	9/10-15/15	10/10-14/14
Number of scales on canthal ridge	5/5-6/6	5/5-6/6	5/5-6/6	5/5-7/7	5/5-6/6	5/6	5/5-7/6	5/5-7/7	5/5-7/6	5/5-6/6
Number of scales betw. frontal and canthal ridge	12/13-25/22	12/12-22/26	14/16-20/21	14/16-20/21	14/14-23/22	20/19	13/16-27/26	16/17-27/26	15/15-27/27	11/11-18/18
Number of scales betw. frontal ridges	3-17	7-20	8-17	8-21	7-15	15	7-18	8-21	8/6	9-8
Number of scales surrounding nostril	7/7-9/9	6/6-9/9	6/6-9/9	6/8-9/9	6/8-9/9	8/8	6/7-9/9	6/7-11/11	6/7-9/9	6/6-9/9
Number of loreal scale rows	4/4-5/6	4/4-7/8	4/4-6/6	4/4-6/8	4/4-7/7	6/6	4/4-6/6	4/4-6/6	4/4-6/6	3/3 4/4*

Table II . (cont'd) Summary of comparative morphological characteristics of *A. c. carolinensis* and *A. c. seminolus* subsp. nov. Excluded are the data of apparent intergrades of *A. c. carolinensis* X *A. c. seminolus*. * One individual (FSM #56045) has 5/6 loreal scale rows and another (AMNH 21243) has 4/5 loreal scale rows.

	Anolis carolinensis carolinensis									*A. c. seminolus subsp. nov.*
	Georgia	So. Carolina	No. Carolina	Alabama	Mississippi	Tennessee	Louisiana	Arkansas	Texas	Florida
Number of loreal scales	22/22- 36/33	19/19- 43-45	22/22- 35-34	20/19- 34/30	22/21- 39/40	35/32	20/23- 37/38	18/18- 39/47	22/21- 36/36	15/16- 27/26
Number of 4th hind toe lamellae	37/38- 43/45	35/35 47-48	37/38- 47-45	37/38- 48-44	36/36 47-45	44/40	37/40- 50/50	36/35- 44/47	37/37- 47/47	33/32- 35/37
Head shape	Blunt	Blunt	Blunt	Blunt	Blunt	Blunt	Blunt	Blunt	Blunt	Sharply pointed
Shape of 4th hind toe pad	1/3-1/2 dilated	1/3-1/2 dilated	1/3-1/2 dilated	1/3-1/2 dilated	1/3-1/2 dilated	1/2 dilated	1/2 dilated	1/2 dilated	1/2 dilated	1/4 dilated
Axillary spot	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present
Mental reaches posteriorly of rostral suture	No	No	No	No	No	No	No	No	No	Yes

A. porcatus Gray has been continually included as a subspecies of *A. carolinensis*, but recent investigators have elevated *A. porcatus* to full species with at least two possible subspecies (Ruibal and Williams, 1961; Ruibal, 1964) which remain undescribed.

Taxonomic variability:

Variations are not surprising in a reptilian species with the range of *A. carolinensis* (Fig. 3, Table II). Loennberg (1894) casually mentioned the existence of a variation concerning the size and shape of the head, but he referred to these types as "short-snouted" and "long-snouted" with variants between the two. Oliver (1955) noticed that east Florida individuals attained a total length of 6 3/4 inches, whereas individuals 60 miles inland reached only 6 inches. Fitch (1976) presented a report on sexual dimorphism, showing that males may be nearly 79% larger than females; this may have been partly responsible for the Loennberg observation.

Smith (1946) is quoted as saying, "It is also not improbable that the species is composed of at least two geographical races." Duellman and Schwartz (1958) performed the first detailed study of Florida variations, noting that examples from southern Florida had an overall smaller body size and less massive head which agrees with Loennberg (1894). They also made note of other aspects from four different areas of Florida:

1. Lower Keys. - Throat fan pink to red; no stripes on throat, but sometimes indistinctly spotted; head scales strongly keeled; head width less than 17 percent of snout-vent length; ventrals slightly larger than dorsals.

2. Upper Keys. - Throat fan red; numerous longitudinal brown stripes on throat; ventrals and dorsals essentially similar in size; head 17 percent of snout-vent length (average ratio 15.8%).

3. Eastern Mainland. - Throat fan red; throat without stripes, but sometimes with series of dashes or spots in longitudinal rows; ventrals half again the size of dorsals; head scales moderately to heavily keeled; average head width/snout-vent length ratio 16.2 percent.

4. Western Collier County. - Throat fan greenish gray or greenish white; no stripes on throat; ventrals slightly larger than dorsals; head scales moderately keeled; head width/snout-vent length ratio 16 to 18 percent (16.8%).

In addition to the above characteristics, Duellman and Schwartz called attention to a specimen from Collier County, Florida, which differed from all others by having lateral and dorsolateral dark brown stripes, larger dorsal scales than ventrals, and smooth head scales. These features led Duellman and Schwartz to hypothesize the following: the mainland species has a strong tendency to break into variant groups within small areas, the specimens from the four regions of Florida may have resulted from introductions from other insular populations, or they developed as a result of the combination of the first two reasons.

Collette (1961) noted a difference concerning the more numerous right front fourth digital lamellae of females from Key West as compared to those from the Mainland (Miami). He also noticed a similar but less substantive difference in males, and a smaller average body length of mainland examples when compared to Key West individuals.

Williams (1969) suggested that the mainland may harbor more than one taxon of *A. carolinensis* as indicated by the variability of snout sizes noted earlier by Loennberg (1894) and Duellman and Schwartz (1958).

Conant (1975) made the same basic observations as Duellman and Schwartz (1958) concerning dewlap coloration and he offers some additional observations. "Males from southern Florida are variable. They may be longitudinally streaked with slate gray on the nape and anterior part of the trunk. Throat fans vary from virtually white through pinks and magentas to blues and purples. Whether these anomalies represent variation with the species or whether a sibling complex of two or more species is involved is unknown at this time." This was also indicated by Smith and Brodie (1982).

Christman (1980) provided a detailed color description of these south Floridian representatives. He listed colors of the dewlap as: pale gray, darker gray, dark magenta, reddish magenta, pink, red, dark red and bright red. The dewlap colors of dark and reddish magenta were considered as intermediate colors between the gray and red-throated forms. His laboratory experiments revealed attempted mating and territorial displays when sexes of both types were placed together, thus suggesting that the lizards themselves do not recognize the different colored dewlaps. Wilson and Echternacht (1987, 1990) present physiological evidence that this species may be polytypic. They indicate the gray-throated forms are of an average smaller mass than the red-throated variety, and the gray-throated morph may be restricted to Florida because of its inability to adapt to cooler temperatures.

The information presented in the preceding paragraph strongly suggest that *A. carolinensis* is confined, with the exception of the Florida Keys and transports, to the mainland. Strong supportive evidence suggest that this species has undergone differentiation in part of its south Florida range which is an indication that subspeciation has taken place. Figure 4 serves to illustrate the morphological variations of *A. carolinensis.*

In light of the reported and new geographical and morphological variations of *A. carolinensis*, it seems practical to indicate the northern and western populations as:

Northern Green Anole (Figs. 1-16, Table II)

Anolis carolinensis carolinensis Voigt

Definition: A subspecies of *A. carolinensis* characterized by the combination of: long, broad and blunt shaped muzzle, mental scale fails to extend posteriorly of the rostral scale, 4-8 loreal scale rows on the right or left sides, 18-47 loreal scales on the right or left sides, absence of an axillary spot in preserved specimens, 4th toe lamellae of the hind leg number 35-50 from the junction of the toe with the foot and extending to the toenail, digital dilation of 4th hind toe extends 1/3-1/2 of toe length, absence of axillary spot.

Dewlap of males and females characteristically red, scarlet, or pink. Heads of individuals east of the Mississippi River are shorter when compared with individuals of the same snout-vent length from west of the Mississippi River, but the author does not consider this significant enough to designate an eastern and western subspecies. They should be considered simply as a short and long headed morphs. The illustration of Cope (1900) is of a short headed morph from an unknown locale.

Description of Neotype: The neotype is an adult male, (Fig. 4), CR 862, collected on September 29, 1929, in Charleston County, South Carolina by collector or collectors unknown. This neotype is designated due to the apparent nonexistence of a holotype.

The snout is somewhat blunt; interparietal is twice as long as ear opening, number of scales on frontal ridge including supraorbital semicircles is 13/13; number of scales on canthal ridge which are in contact with the loreals is 5/6; number of scales between the frontal and canthal ridges are 12/13 which are 1-4 and 1-4 scales wide, respectively; 14 scales between frontal ridges up to the narrowest area between the supraorbital semicircles which is 1-3 scales wide; supraoculars grade down in size posteriorly; temporals are of various sizes; mental barely exceeds the posterior margin of the rostral; 3/3 scales between rostral and nasal scales; 5/6 loreal scale

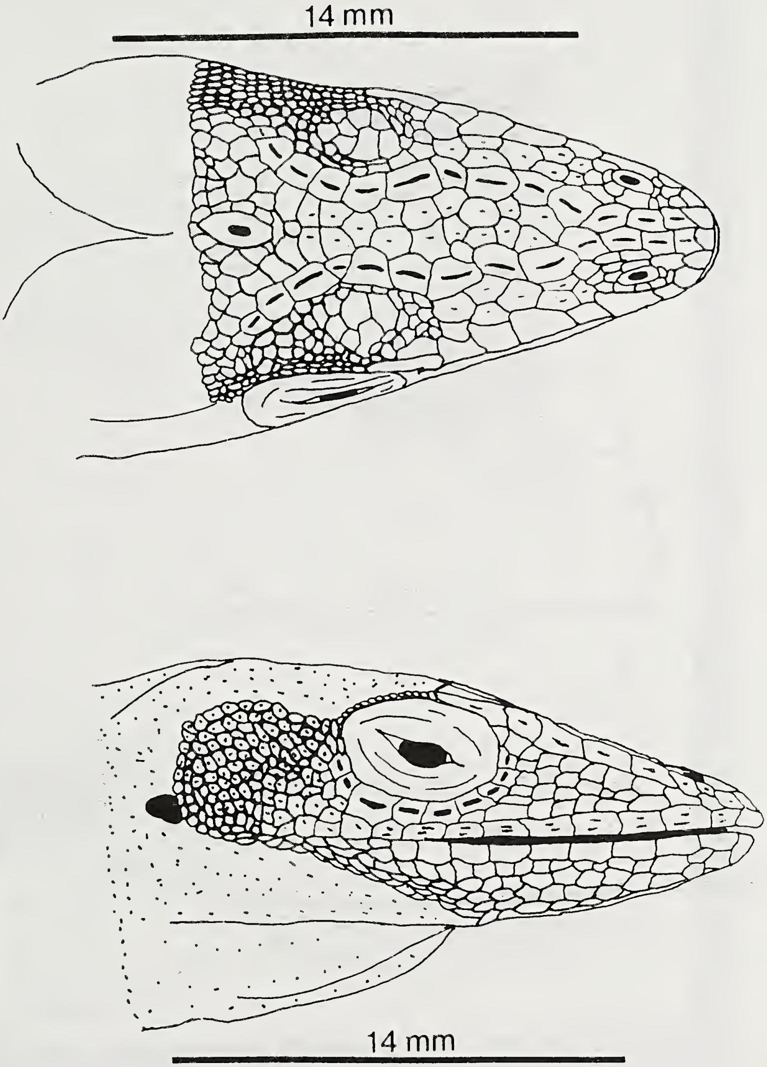

Fig. 4. Line drawings of the dorsal and lateral head aspects of *A. c. carolinensis* (CR 862) from Charleston Co., South Carolina, which illustrates a short headed morph and neotype.

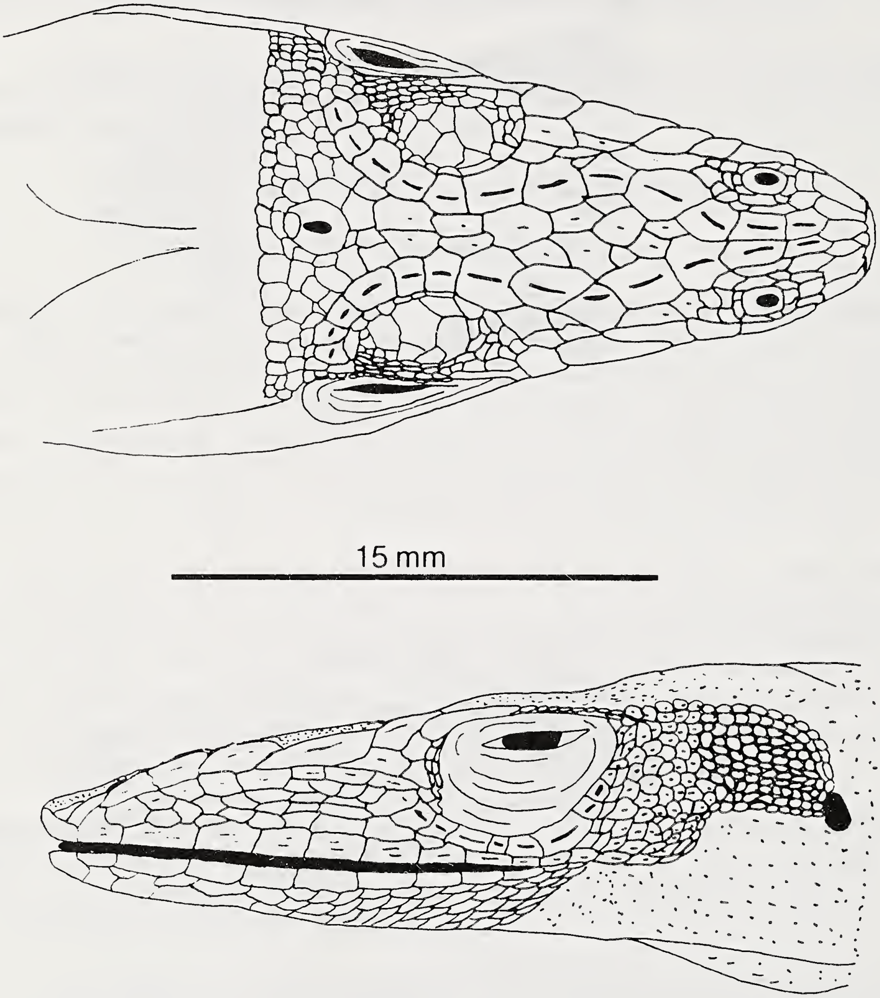

Fig. 5. Line drawings of the dorsal and lateral head aspects of *A. c. carolinensis* (NC 1982.4.12.1L) from Corsicana, Navarro Co., Texas which illustrates a long headed morph.

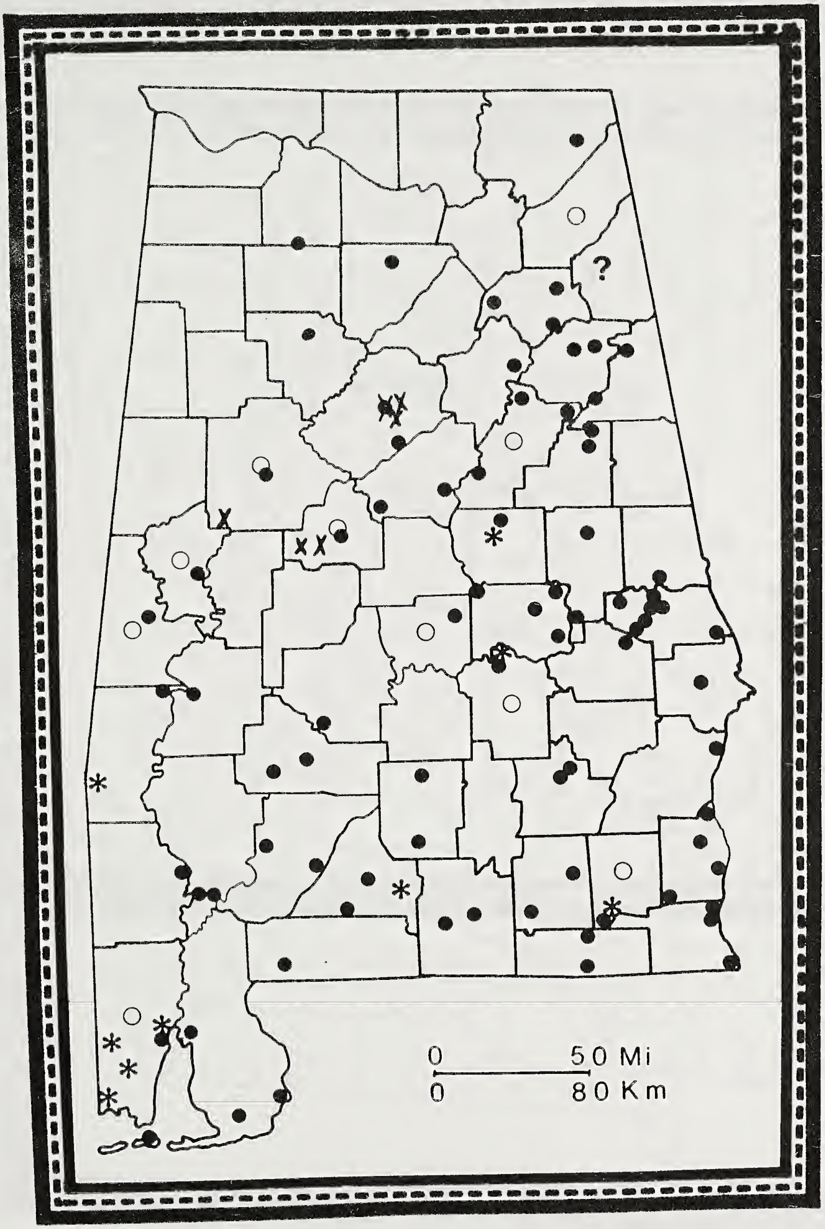

Fig. 6. Locality recording of *A. carolinensis* in Alabama. Hollow circles represent county records while solid circles represent specific localities and the question mark represents a questionable locality. Specimens examined by the author are listed as X's for intergrades and asterisks for *A. c. carolinensis*.

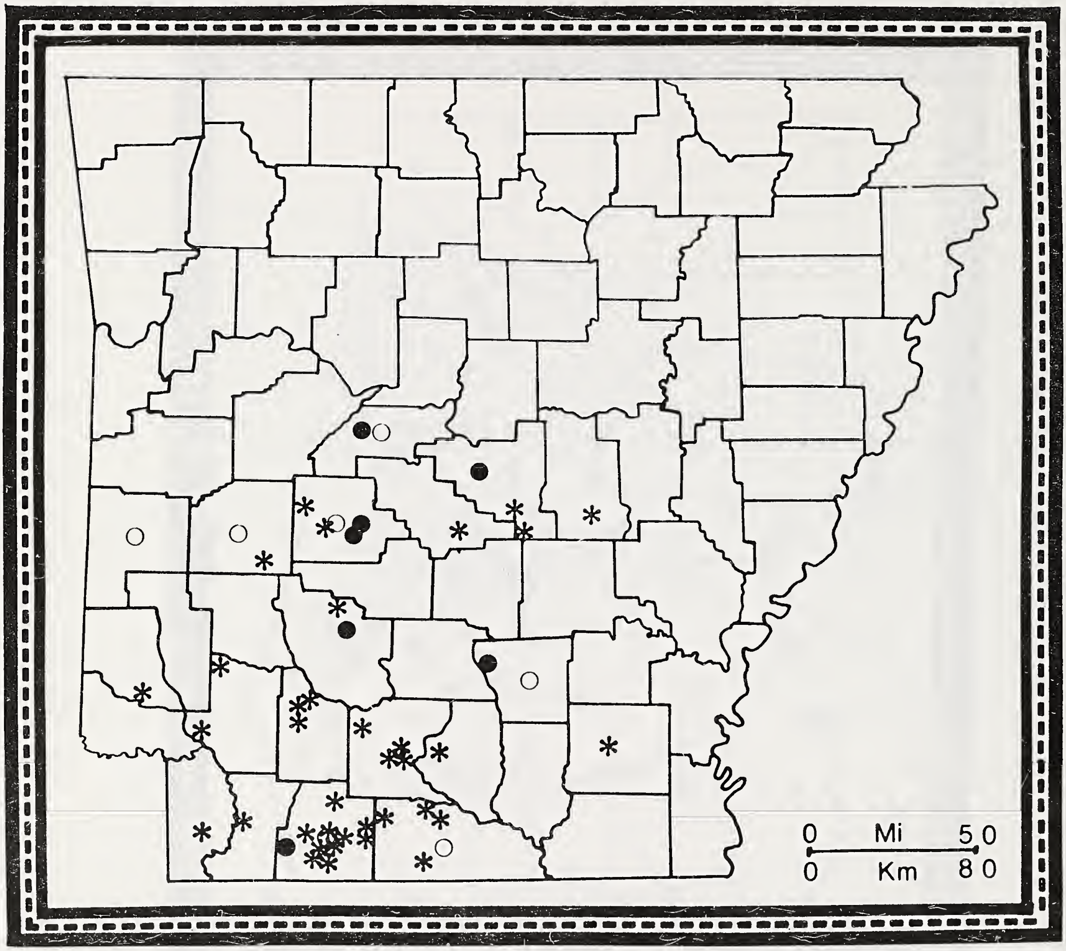

Fig. 7. Locality recordings of *A. carolinensis* in Arkansas. Hollow circles represent county records while solid circles represent specific localities. Specimens of *A. c. carolinensis* examined by the author are represented by asterisks.

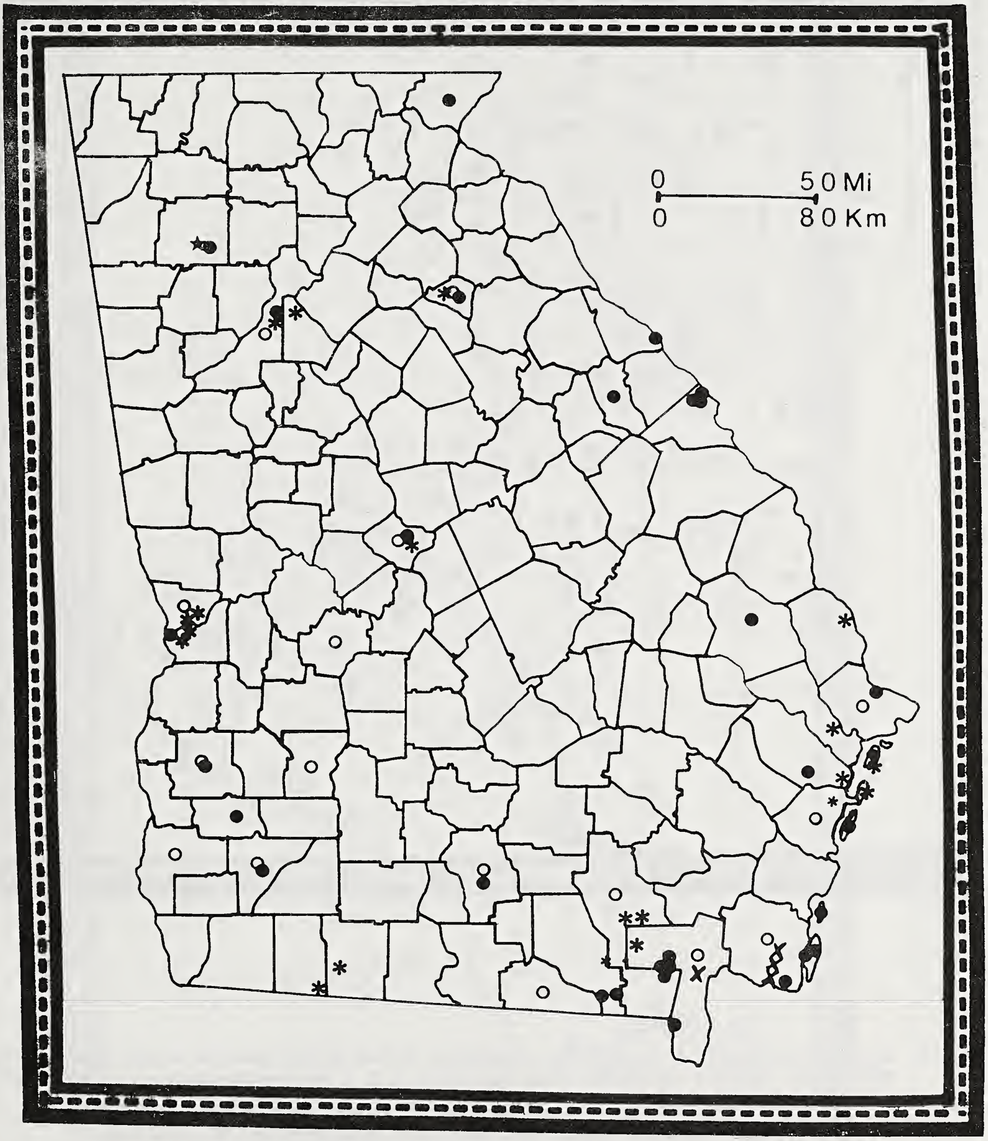

Fig. 8. Locality recordings of *A. carolinensis* in Georgia. Hollow circles represent county records while solid circles represent specific localities and the star represents a fossil record. Specimens examined by the author are listed as X's for intergrades and asterisks for *A. c. carolinensis*.

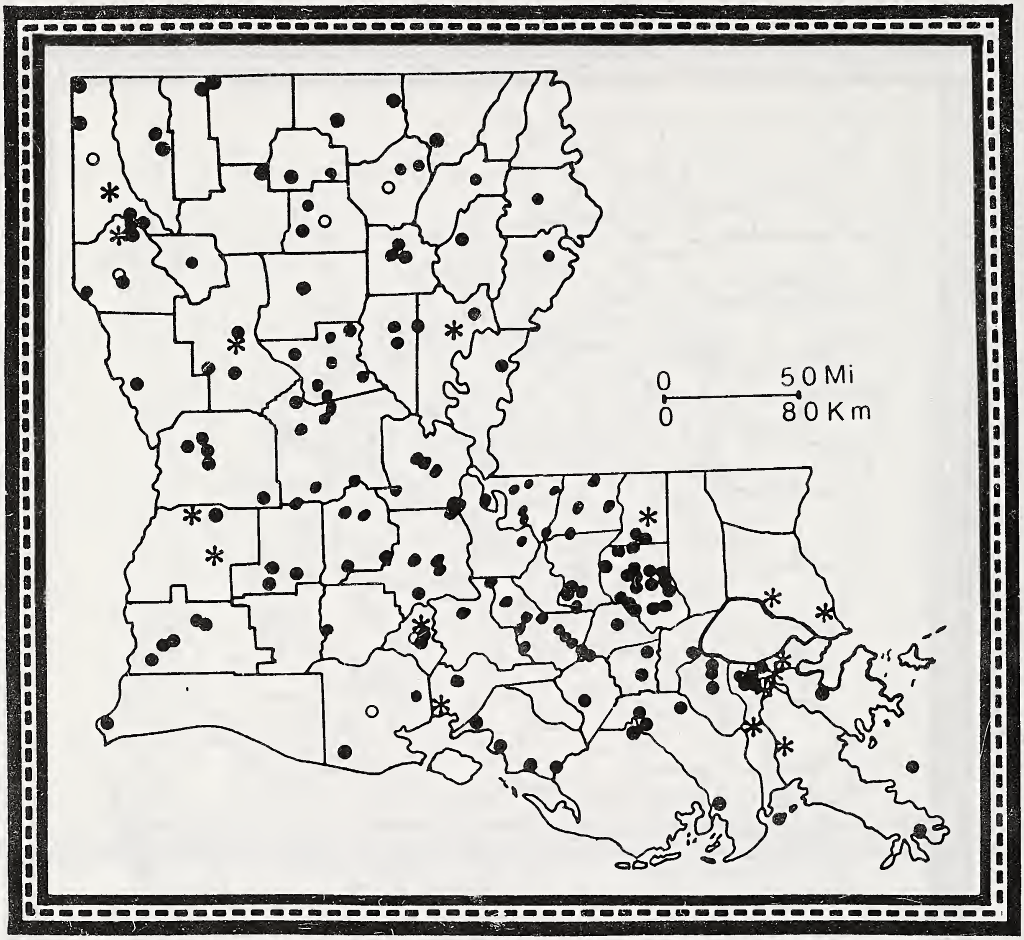

Fig. 9. Locality recordings of *A. carolinensis* in Louisiana. Hollow circles represent county records while solid circles represent specific localities. Specimens of *A. c. carolinensis* examined by the author are represented by asterisks.

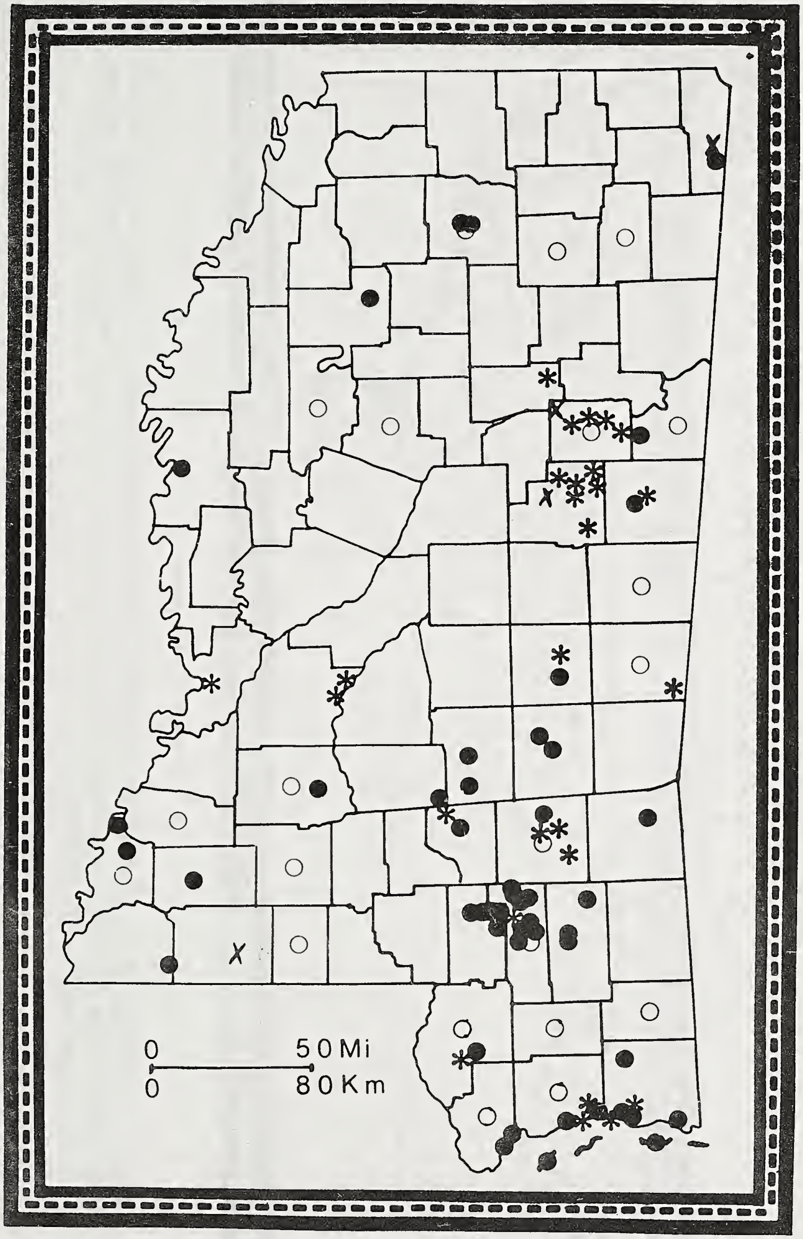

Fig. 10. Locality recordings of *A. carolinenesis* in Mississippi. Hollow circles represent county records while solid circles represent specific localities. Specimens examined by the author are listed as X's for intergrades and asterisks represent *A. c. carolinensis*.

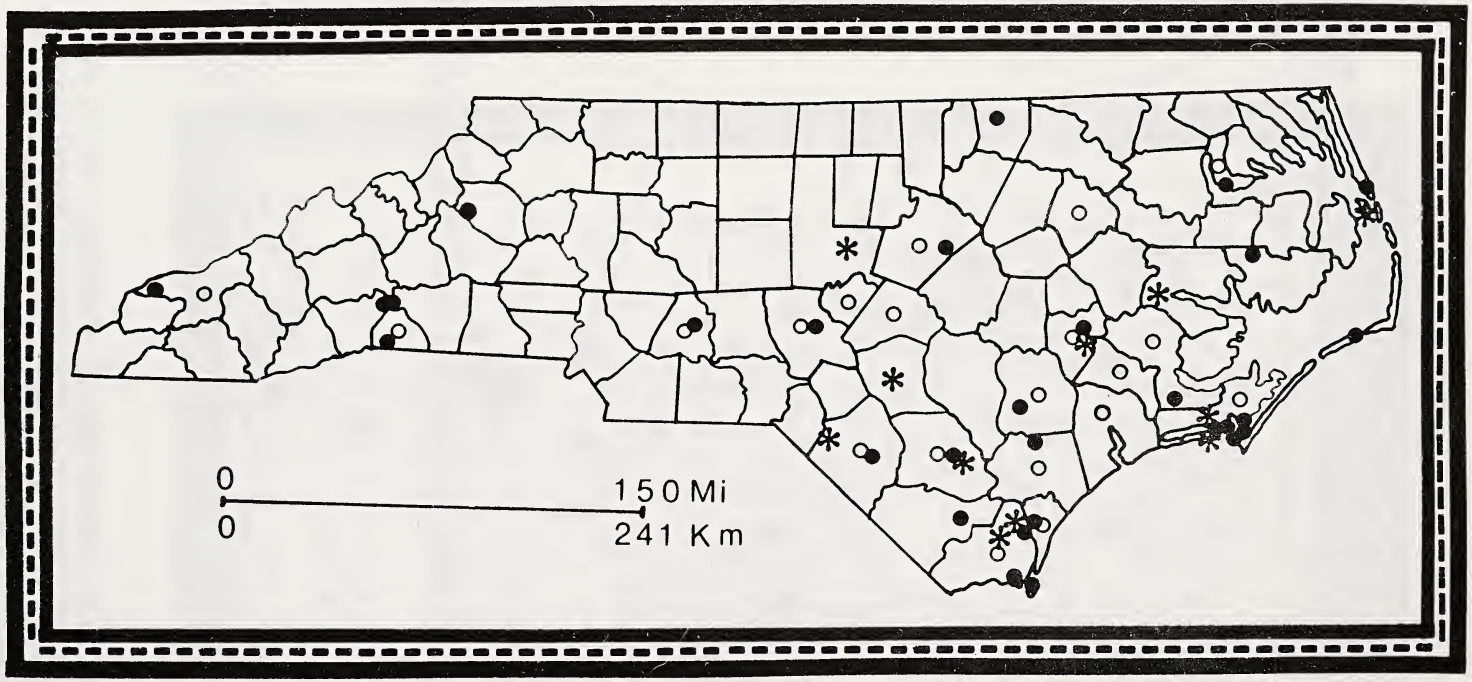

Fig. 11. Locality recordings of *A. carolinensis* in North Carolina. Hollow circles represent county records while solid circles represent specific localities. Specimens of *A. c. carolinensis* examined by the author are represented by asterisks.

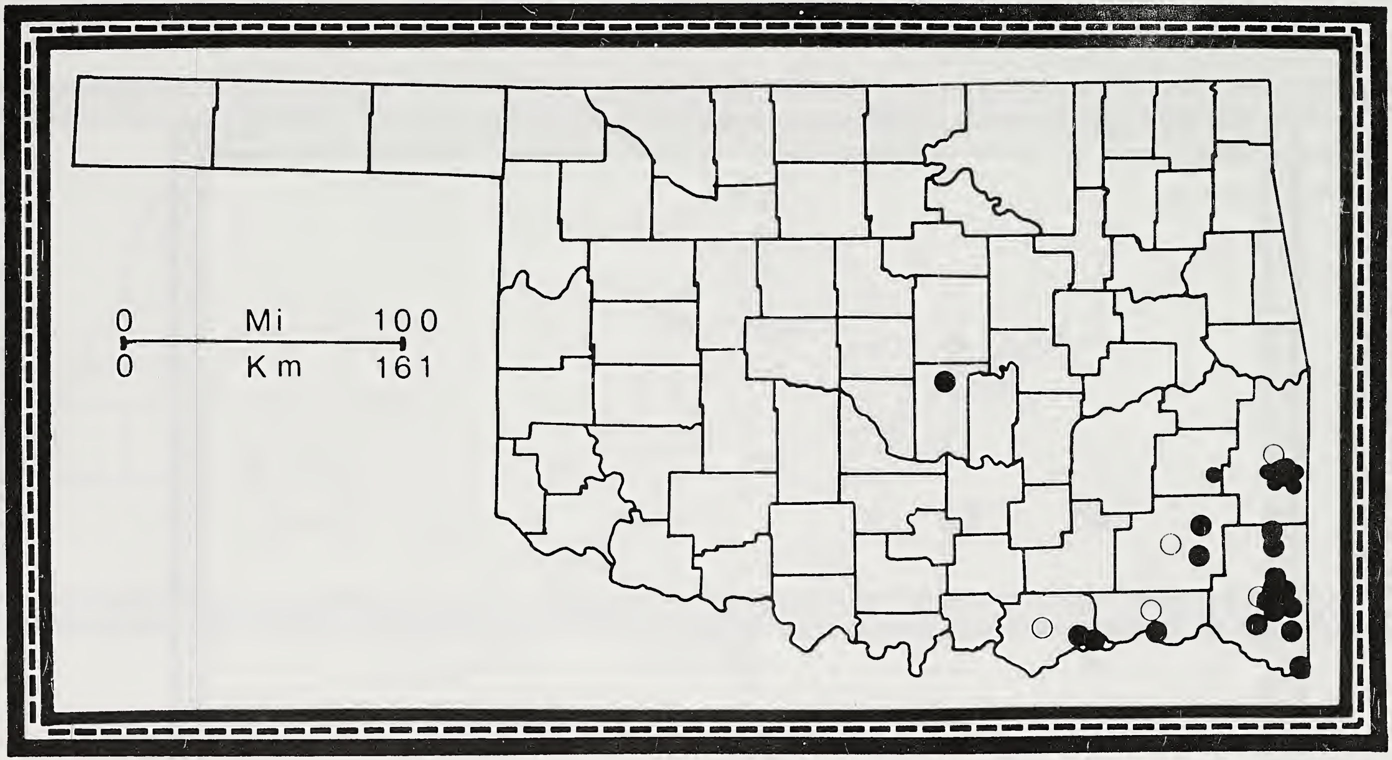

Fig. 12. Locality recordings of *A. c. carolinensis* in Oklahoma. Hollow circles represent county records while solid circles represent specific localities.

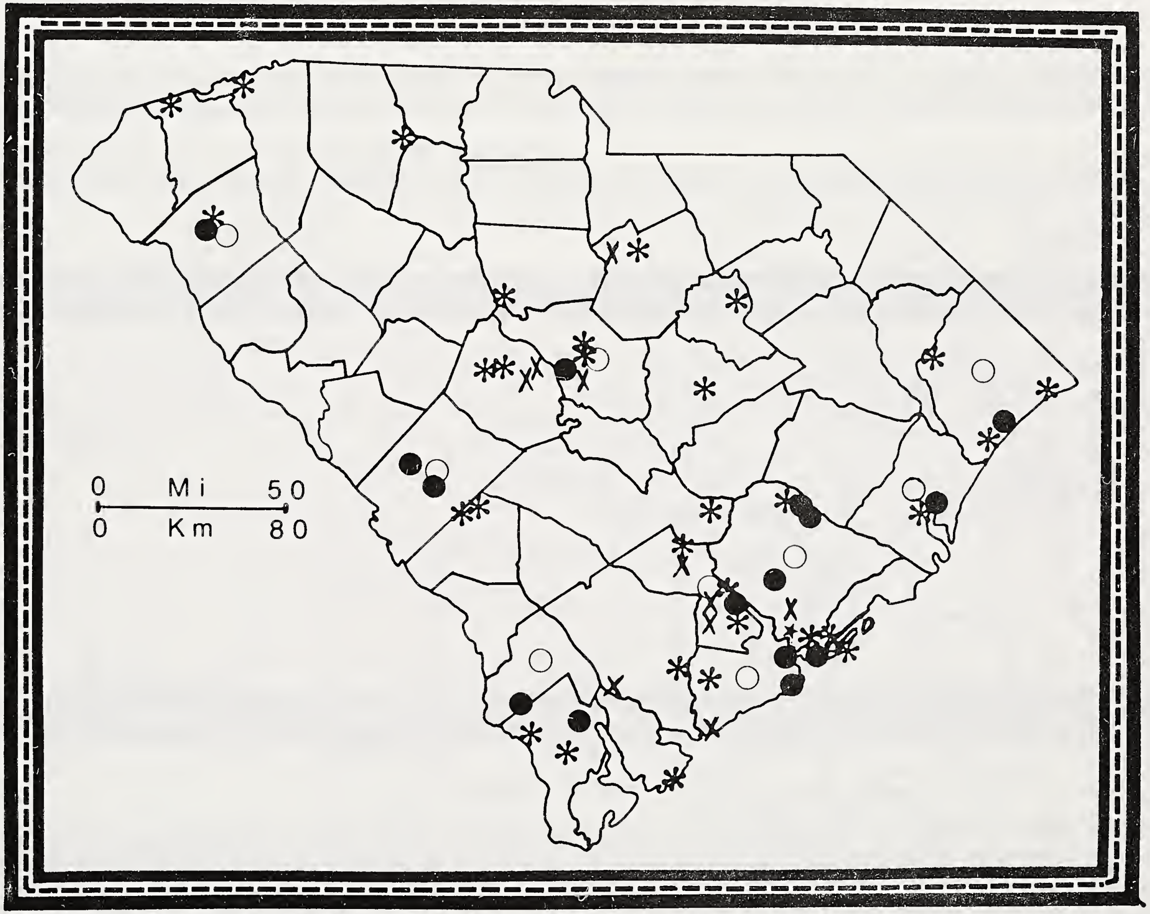

Fig. 13. Locality recordings of *A. c. carolinensis* in South Carolina. Hollow circles represent county records while solid circles represent specific localities. Specimens examined by the author are listed as X's for intergrades, asterisks for *A. c. carolinensis*, and a star represents the locality of the neotype.

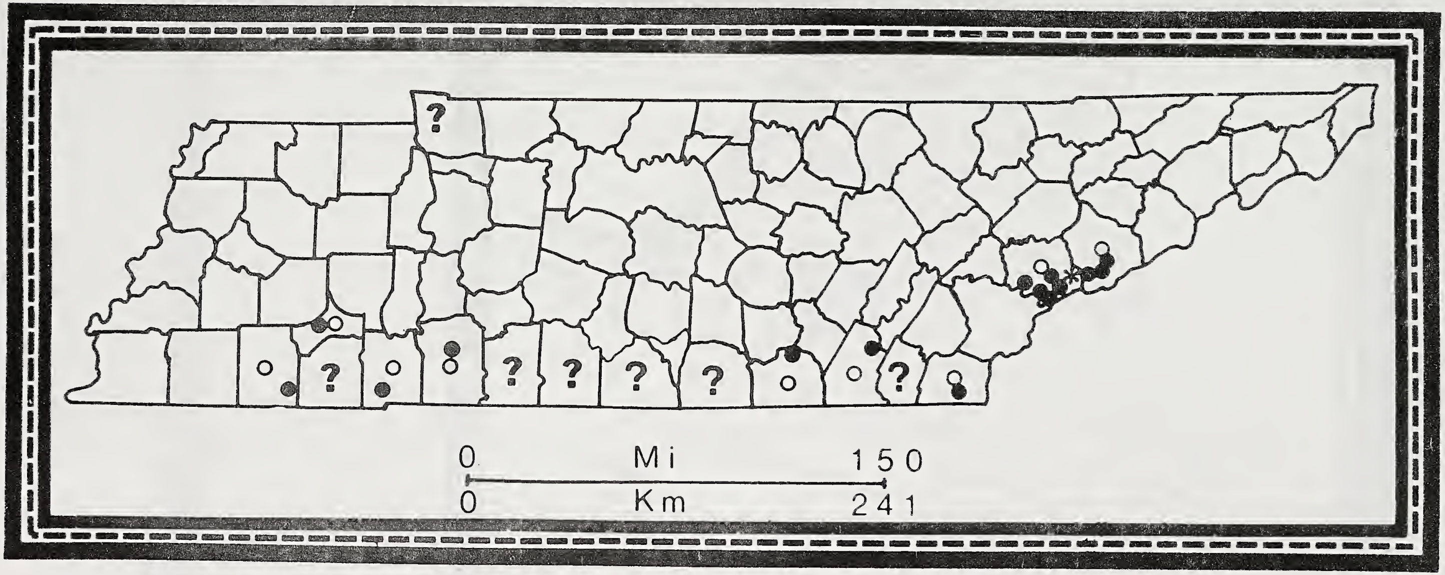

Fig. 14. Locality recordings of *A. carolinensis* in Tennesse. Hollow circles represent county records while solid circles represent specific localities, and the question marks represent unconfirmed county localities. A specimens of *A. c. carolinensis* examined by the author is represented by an asterisk.

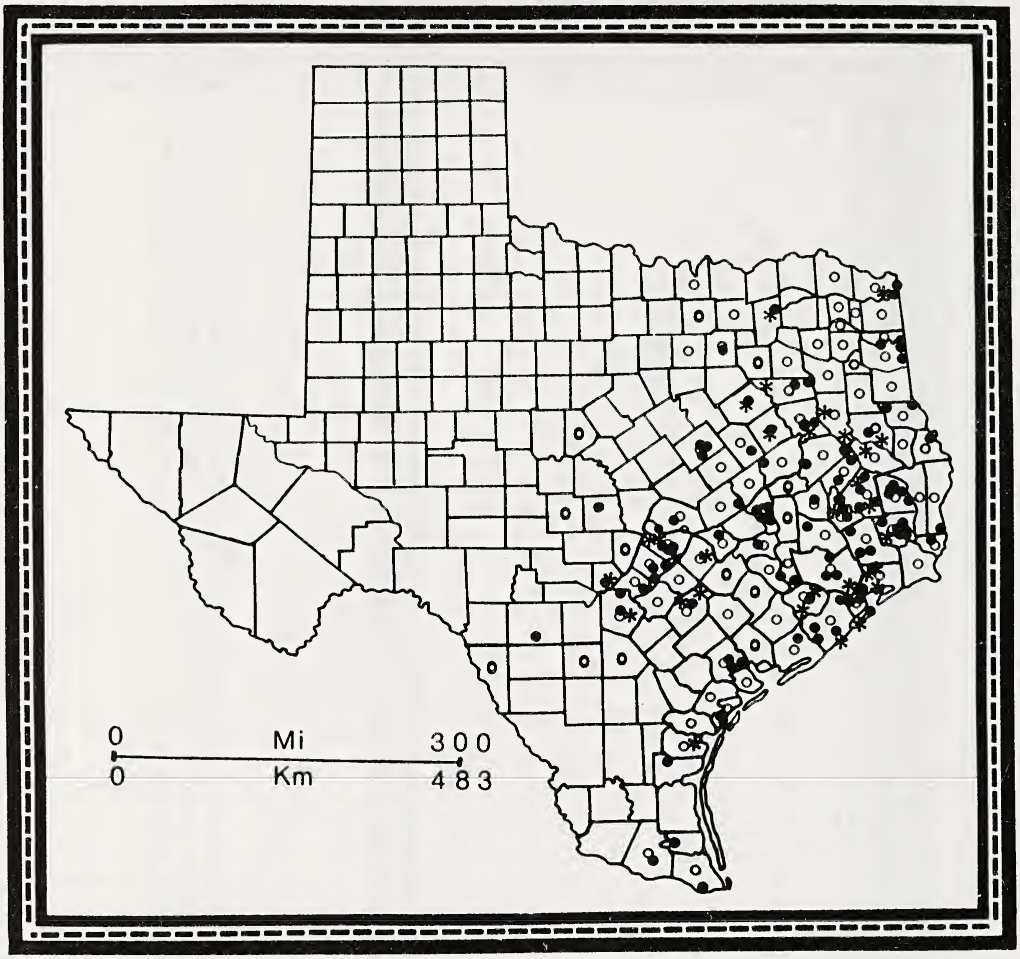

Fig. 15. Locality recordings of *A. carolinensis* in Texas. Hollow circles represent county records while solid circles represent specific localities. Specimens of *A. c. carolinensis* examined by the author are represented by asterisks.

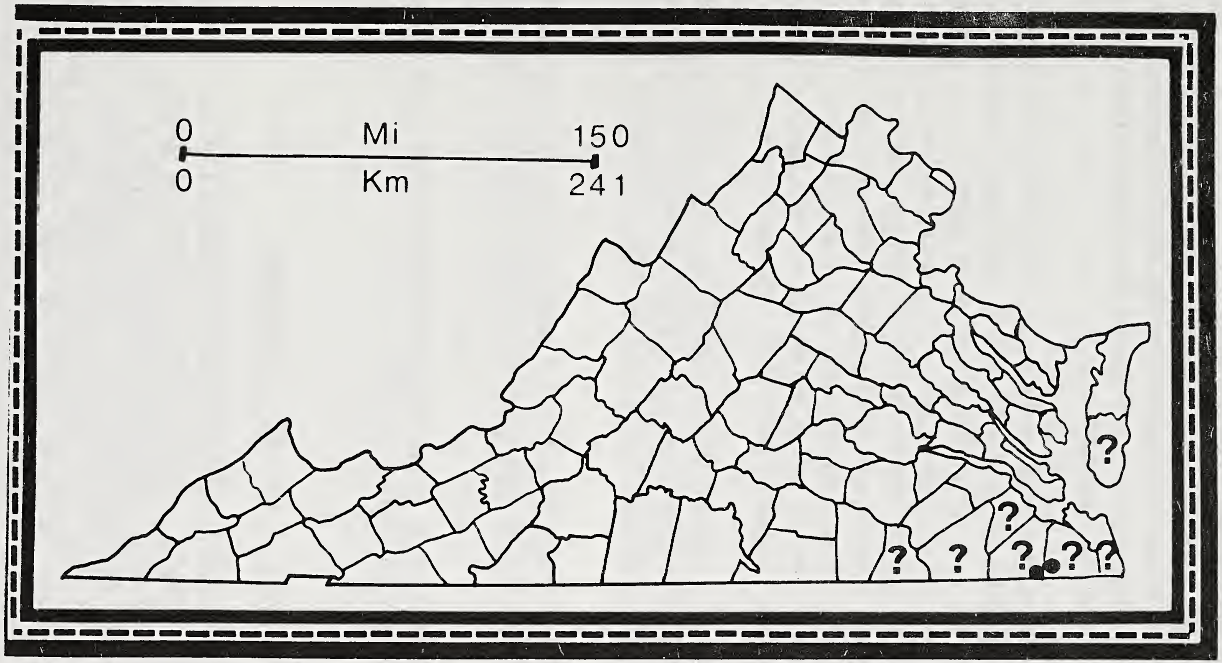

Fig. 16. Locality recordings of *A. carolinensis* in Virginia. Solid circles and question marks represent two questionable recordings.

rows; 28/27 loreal scales; head scales keeled, loreals slightly so; ear opening is oval; 10/10 upper labials; 10/9 lower labials, mental divided; dorsals with blunt keels, ventrals somewhat more strongly keeled, hind leg strongly keeled with sharp keels; presence of 2 postanal scales separated by one scale; adpressed hind leg fails to reach ear opening; digital dilation of 4th toe lamellae of hind leg is between 1/3 - 1/2 of the toe length; 41/40 lamellae present on the 4th toes of the hind legs.

Coloration in preservative is as follows: top of head, back and tail dark brown; back and nape of neck with slight evidence of grayish-black reticulations on anterior 1/4 of trunk; small dark blotches on posterior 3/4 of trunk; dorsal surface of limbs dark brown with evidence of grayish-black blotches; presence of dark brownish-black postocular blotch between the eye and ear opening; absence of axillary spot; ventrum dark beige with evidence of dark brown; thin, longitudinal gular stripes, but abdomen consists of slight indications of small brown dots; ventrum of rear legs somewhat darker than the venter; absence of a dorsal stripe.

Measurements of the neotype are as follows: length of head from interparietal to tip of snout is 14 mm; length of right hind leg is 36 mm; length of right foreleg is 22 mm; snout-vent length is 59 mm; and length of the tail (intact) is 119 mm.

The distribution is presented in Fig. 2 and all the state maps with the exception of Florida (Figs. 6-16) with some new county distribution records noted.

Etymology: *A. c. carolinensis* is apparently named after the state of South Carolina where Catesby was known to visit.

Anolis carolinensis carolinensis

Specimens examined: AMNH 28707-09, 65594-95, 66504, 97001, 104740-41, 46729, 1975, 65616, 88355, 92747, 74536, 57978-79, 57981, 104736, 104738, 114550, 110684-93, 114581-82, 66502-03, 118584, 126626, CR 126-128, 158, 479, 490, 826-865, 867-871, 875-898, 900-904, 906-907, 910, 913-922, 980-996, 1000, 1011, 1021-1025, 1029, 1050, 1185, 1187-1188, DMNH 34-35, 84-85, 164-165, 361, 478, 869, 1126, 1139, 1145, 1161-62, 1175-76, 1182-84, 1487, 2025-26, 2838, 2932-33, 3664-68, 3683-84, 3686-94, 4178, FMNH 2700, 5784-87, 8136-38, 18466-67, 21487-89, 27031-32, 34819-27, 37536, 40806, 40941, 41256, 41305-06, 42357, 42506, 48646, 48819, 62041-42, 69321, 74741, 94750-54, 94756, 94761, 94763-65, 162952-60, 171944-50, 192452-55, 192457-67, 192469-71, 192479-80, 192482, 192484, 192488-90, 192496, 194377-80, 194385, 194392-94, LACNHM 3797-3801, 8550, 27224-29, 35056-57, 36440, 36466-67, 15585-92, 61527, 61529-31, 66645-56, 93925-35, 106928-40, 121534, 126270, 130746-53, 121233-39, 131565, 132840-41, 135074, MPM 513,3048-50, 11816-21, 5454-55, 5459-61, 5476, 5478-79, 7006-07, 7187, 8560-62, 10030, 12270, 12932, 13136-37, 13142, 13159, 13328-31, 13142, 15042-49, 15051-57, 15839, 16087, 16147, 16139, 16140, 17162, 17600, 17635-38, 17694-95, 19606, 19622, 19624, NC 1977.10.9.8L, 1978.10.8.23L-.24L, 1979.3.11.1L, 1979.3.15.1L, 1979.4.12.1L, 1979.5.4.1L-.3L, 1980.3.28.1L, 1980.4.2.1L, 1980.6.12.1L, 1980.6.20.1L, 1980.14.12.1L, 1982.9.9.1L, 1982.9.26.1L-.3L, 1983.8.29.1L-.10L, 1984.12.30.1L, 1984.4.20.1L-.2L, 1984.4.29.1L, TMM 9180-82, 9601, 9836, 9122, 9753-59, 9881-82, 41816-18, 20460, 10101, 14232-33, 14268, 14288-89, 14292, 14365, 14367-72, 9610-19, 9602, 673, 1532, 6910-13, 9104-05, 9125, 9133, 13123, 13600-01, 14538, 14540-41, 18995-97, 19001-03, 19010-12, 21187, 21254-65, 22463-67, UAM 68-735-6, 68-735-7, 68-735-9, 68-735-85, 68-735-1620, 68-735-1621, UCMZ 14792-93, 8129-30, 11105, 43395-97, 15058-59, 150154-55, 181158, 53788-89, 53810, 8131-33, 39535-38, 43398-409, 53785-87, 150160, 80046, 39664-66, 64493, 68406-07, 78225, 78245, 98811, 98819-20, 128055-59, 150156-57, 181159-61, 187474-75.

The Florida population is a small one located in southwest Florida which seems to undergo a broad area of intergradation with *A. c. carolinensis* over most of Florida and the neighboring states (Fig. 2).

Although the dewlap of males is considered to be gray, it should not be used alone as an identification feature, yet other features are notable. Therefore, the Floridian population of *A. carolinensis* is designated as:

Southern Green Anole (Figs. 2-3, 17-18, Table II)

Anolis carolinensis seminolus subsp. nov.

Definition: A subspecies of *A. carolinensis* which is characterized by the combination of: sharply pointed or narrow muzzle; mental scale exceeds past the posterior margin of rostral; 3-4 loreal scale rows on the right or left sides; 15-27 loreal scales on the right or left sides; presence of dark and oval or oblong axillary spot which is bordered by light colored scales in preservative, 4th toe of hind leg is dilated at the extreme 1/4 length of the toe; lamellae of the 4th toe of the hind leg may vary from 32-39 from the junction of the toe with the foot and extending to the toenail. Dewlaps may be gray or perhaps pinkish. Comparative features of this taxon and *A. c. carolinensis* are presented in Table II.

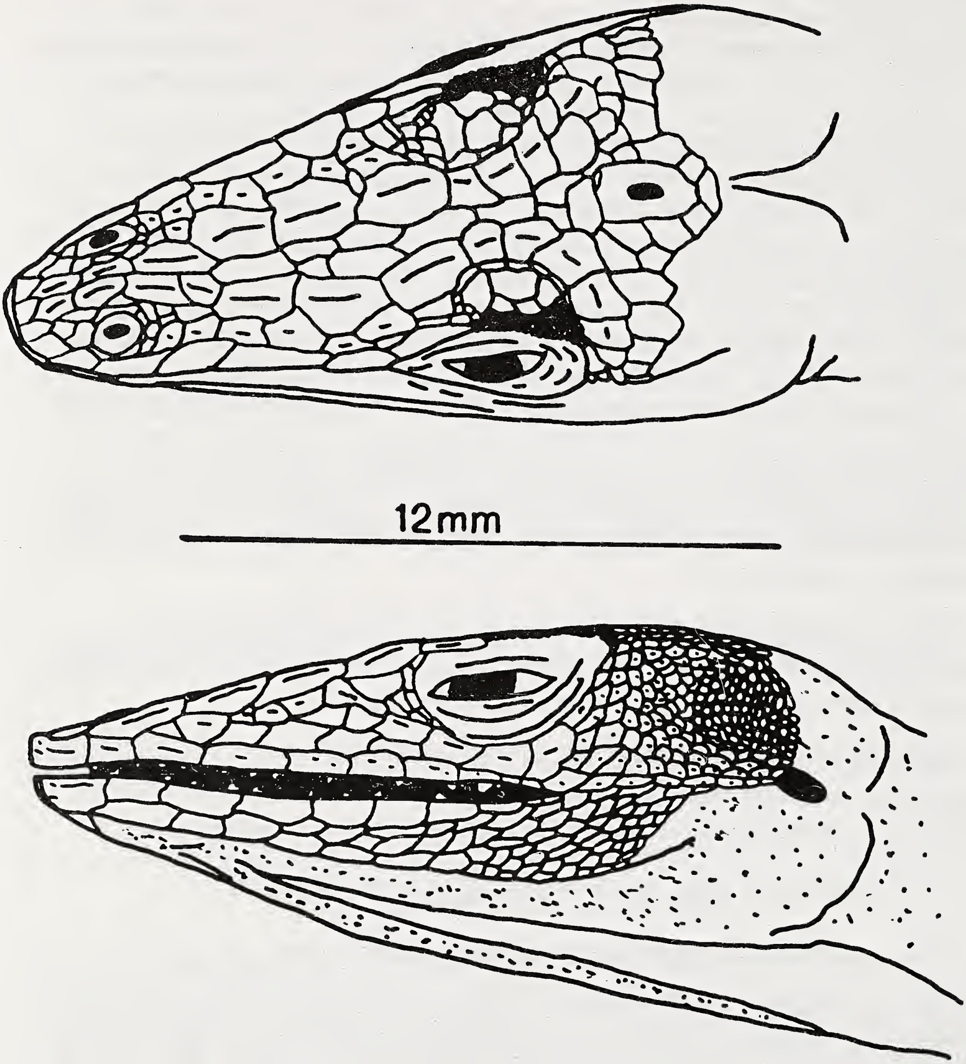

Fig. 17. Line drawings of the dorsal and lateral head aspects of *A. c. seminolus* subsp. nov. (UCMVZ 53793) from 6.8 mi. WNW Murdock, Sarasota Co., Florida, which illustrates the holotype.

Description of holotype: The holotype is an adult male (Fig. 17, UCMZ 53793, collected on April 9, 1950, 6.8 miles WNW of Murdock, Sarasota County, Florida, by Robert Stebbins. Paratypes are UCMZ 53792 and 53794-95 with the same collecting data as the holotype.

The snout is sharply pointed; interparietal twice as long as ear opening; number of scales on frontal ridge including supraorbital semicircles 12/12; number of scales on canthal ridge in contact with the loreals 5/4; number of scales between frontal and canthal ridges 16/16 which are 1-3 and 1-4 scales wide respectively; 7 scales between frontal ridges up to the narrowest area between the supraorbital semicircles which are 1-2 scales wide; supraoculars do not grade posteriorly; temporals are of different sizes and shapes; mental reaches beyond posterior margin of the rostral; 3/3 scales between rostral and nasal scales, 4/3 loreal scale rows, 13/15 loreal scales; head scales keeled, loreals slightly so; ear opening oval; 9/9 upper labials; 9/9 lower labials, mental divided; dorsals nearly same size as the ventrals and slightly keeled, ventrals somewhat more keeled than dorsals; laterals smaller than dorsals and ventrals; scales on top of forearm keeled with blunt keels; scales on top of hind leg somewhat keeled; presence of 2 postanal scales which are in contact; adpressed hind leg fails to reach ear opening; digital dilation of 4th toe lamellae of the hind leg is 1/4 length of toe; 37/36 lamellae present on 4th toes of hind legs.

Coloration in preservative is as follows: top of head, neck and rear half of the back and tail dark brown; back and nape of the neck show evidential color (green-black) indicating an injury; the only dorsal markings are occasional dark spots barely evident down vertebral area; dorsum of limbs slightly lighter than back with faint evidence of an axillary spot surrounded by a single layer of white scales; ventrum beige without any noticeable markings; ventrum of rear legs somewhat darker than belly; absence of dorsal strip.

Measurements of holotype are as follows: length of head from interparietal to tip of snout 12 mm; width of head through the center of the eyes 8 mm; length of right hind leg 32 mm; length of right foreleg 21 mm; snout-vent 54 mm; and length of the tail (damaged but still intact) 98 mm.

Etymology: *A. c. seminolus* is named after the Seminole Indians of Florida.

Subtle behavioral differences are known to occur when *A. c. carolinensis* and *A. c. seminolus* are compared. Milstead (1967) reports that *A. c. carolinensis* will display from sites on vertical surfaces with the longitudinal axis up, down, or oblique along a tree trunk, yet Christman (1980) notes that the Florida gray-throated forms (*A. c. seminolus*) will usually perch on reeds and other vertical surfaces facing downward, and when disturbed, will run to the ground to avoid capture. The intergrade anoles (*A. c. carolinensis* X *A. c. seminolus*) will typically perch on larger sticks and tree trunks and, when disturbed, will move upward. The subspecies identifications being those of the current author. Christman (1980) observes that adult males of the gray-throated forms will respond to introduced males with red dewlaps (*A. c. carolinensis* or perhaps *A. c. carolinensis* X *A. c. seminolus*) and with a display followed by an attack in the same way they respond to their own kind. Male gray-throated forms will also display to and mount females regardless if they are gray-throated or red-throated (Christman, 1980).

Anolis carolinensis seminolus

Specimens examined: AMNH 107338-39, 21240-41, 21243-44, FMNH 23225-26, 94744, 94749, 192444, FSM 56045, LACMNH 3804, 15596-97, UCMZ 53791-93, 53795, 53803-05.

Anolis carolinensis carolinensis X *Anolis carolinensis seminolus*

(Figs. 2, 6, 8, 10, 13, 18)

Specimens examined: AMNH 104737, 85788, 114549, 117851, 88600, 127256, 93788, 6991-95, 22419, 21242, 76-78, 80-82, 36489, 22381, 2422-23, 63907, CR 480-81, 834, 872, 873-74, 899, 905, 908, 909, 911-12, FMNH 5803, 8128, 8130, 42662-65, 94733-35, 94739-40, 94742, 94746, 94755, 16815-18, 192451, 192456, 192468, 194384, 208310, FSM 3214, 56040-44, 56046-49, 8821, 17233-36, 19712, 1433, 2461, 3942, 4150, 6946, 9424, 56021-39, 34430, 34445, 9255, 9836, 55903-99, 56000-03, LACMNH 15605-07, 61500-14, 3802-03, 15593-95, 15598-04, 61528, 74311-13, 116113-115, MPM 504-512, 1947, NC 1985.5.20.1L, UCMZ 36583-86, 53799-800, 53797-98, 53801-02, 53806, 40957-58.

Summary

Anolis carolinensis is a wide ranging mainland anole which exhibits enough variation to be considered as a polytypic species. A total of 27 names or variation of names are applicable to this taxon.

Various systematic problems have existed regarding this lizard. The virtual non existence of a holotype along with the lack of a proper type locality

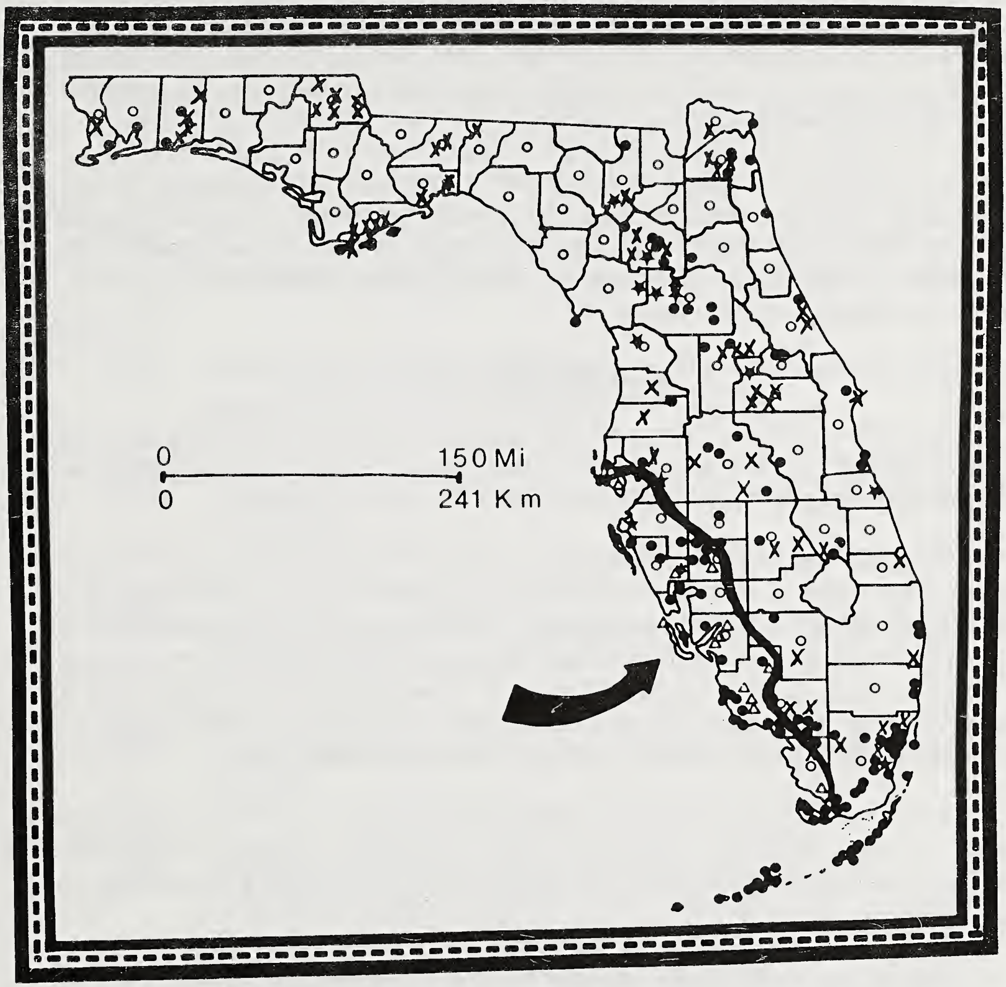

Fig. 18. Locality recordings of *A. carolinensis* in Florida. Hollow circles represent county records while solid circles represent specific localities and stars represent fossil records. Specimens examined by the author are listed as X's for intergrades, hollow triangles for *A. c. seminolus*, and an asterisk represents the type locality.

locality and questionable authorities of the scientific name have caused a great degree of systematic chaos.

This study provides information on 12 morphological characters which are used to describe the mainland populations of *A. carolinensis*. The result is the description of a subspecies from Florida (*Anolis carolinensis seminolus* subsp. nov.) which is readily discernable from the subspecies of the rest of the species range.

In addition, a neotype is designated in absence of a holotype for the species and Voigt is considered as the proper authority. Commonly used names of the 1800's and early 1900's (*A. bullaris* and *A. principalis*) are considered *nomina dubia*. The neotype locality is designated as Charleston, Charleston County, South Carolina.

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STRIKE-INDUCED CHEMOSENSORY SEARCHING: DO RATTLESNAKES MAKE ONE DECISION OR TWO?

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Abstract

The rate of tongue flicking was higher after prairie rattlesnakes struck warm models of prey than after the same snakes struck identical models at ambient temperature. This variation in post-strike behavior suggests that a snake's decision to deliver a predatory strike is not automatically followed by a full expression of searching behavior. Hence, there must be a second decision, made during or following the strike, that uses additional information to govern post-strike searching behavior.

Rattlesnakes typically release adult rodent prey immediately after envenomating them, allowing the wounded prey to wander from the site of attack (Kardong, 1986). Within 1-5 min the snakes begin to flick their tongues at a high rate while arcing their heads in semicircular movements along the substrate. This pattern of behavior is called strike-induced chemosensory searching (SICS), and it facilitates locating and following of the prey's chemical trail (see Chiszar *et al.*, 1983, for a review). Upon striking a rodent, SICS usually appears at full intensity. Consequently, it is possible that the decisions to strike and to exhibit SICS are made simultaneously (i.e., there is only one decision, and it determines both striking and SICS). If this is true, then SICS ought to be seen at the same intensity whenever predatory strikes are delivered.

On the other hand, the decision to strike and the decision to search may be based on different cues, in which case two separate processes are involved. For example, a snake might strike a prey model based on its visual similarity to a rodent, but appropriate thermal cues might be necessary to activate SICS. If such ideas are correct, then it should be possible for visually appropriate models to elicit predatory strikes that are followed by lower levels of SICS than are seen with models that are both visually and thermally appropriate.

Method

Adult prairie rattlesnakes (*Crotalus viridis*, n = 9), maintained individually (pen dimensions: 180 x 66 x 81 cm) were observed. Rodent models were black balloons (11 cm long) that contained 40-50 ml of tap water. This created an object, roughly of mouse size and shape, with a girth of 9-10 cm at one end, tapering to a girth of 2-3 cm at the other. The water was either at room temperature (26° C) or at rodent body temperature (38° C). The models were suspended (from the narrow end) into a snake's cage, much like euthanized rodents were typically presented at feeding time. The snakes were deprived of food for 5-7 days prior to each presentation. Models remained suspended in the cages within five cm of the snakes' heads until they were struck, or for one minute. If no strike was delivered, the model was withdrawn and the trial was terminated.

The pen was partitioned into two compartments (120 x 66 x 91 and 60 x 61 x 91 cm) separated by a plywood insert that contained a guillotine door. The snakes lived in the small compartment. After strikes were delivered to the model, the door was opened, giving snakes access to the large compartment which contained a rodent trail. We recorded the rate of tongue flicking for 20 minutes or until the snake reached the end of the trail (whereupon it found and ingested a hidden mouse carcass). See Golan *et al.* (1982) for further methodological details. Each snake received seven trials with warm models and seven trials with cool ones. Trials occurred at the rate of two per week per snake, with warm and cool models presented in a randomized sequence. Since each snake was observed with warm and cool modes, most inferential statistics reported below are t tests for repeated measurements.

Results

Strikes. Snakes struck on all trials involving warm models but on only 78% of trials involving cool ones ($t = 1.88$, $df = 8$, $0.10 > P > 0.05$), agreeing with the well-known importance of thermal cues in the triggering of predatory attack by pit vipers. Although some snakes refused to strike cool models on some trials, all snakes struck them on at least two trials. This gave rise to substantial variability in the proportion of trials on which cool models were struck (20%-100%) and to the relatively low t value reported above. If trials are treated as independent events, permitting a Chi Square analysis, then the difference between warm and cool models becomes stronger ($X^2 = 15.75$, $df = 1$, $P < 0.05$). We do not want to argue for this questionable application of Chi Square, instead we merely wish to make the point that at least marginal evidence exists that more strikes were directed to warm than to cool targets.

SICS. Here we consider only those trials on which strikes were delivered to models. For each snake we calculated two averages: (1) the mean rate of tongue flicking after striking warm models, and (2) the mean rate of tongue flicking after striking cool ones. These values were then averaged over snakes (see Table 1), and it was clear that higher rates of tongue flicking were seen following strikes at warm models (t = 2.48, df = 8, P < 0.05).

Table 1. Mean Rate of Tongue Flicking by Prairie Rattlesnakes (n = 9) After Striking Warm (38°C) and Cool (26°C) Models of Rodent Prey

	Warm Models	Cool Models
Mean	41.3	27.3
Standard Error	4.2	5.4

Correlated with this difference in the rate of tongue flicking was the fact that snakes followed trails and discovered hidden prey carcasses on 89% of trials involving strikes to warm models, whereas this occurred on only 72% of trials on which cool models were struck (t = 3.54, df = 8, P < 0.05). Hence, there were trials on which snakes struck models but did not exhibit post-strike searching behavior and did not follow the trails available to them. Importantly, this happened more often after cool models were struck than after warm ones were struck.

Discussion

Snakes more frequently struck warm models than cool ones, but the latter models were struck on a substantial number of trials. We take this outcome to mean that visual cues alone can elicit predatory strikes (at least in snakes that are accustomed to striking rodents suspended from tongs), and that thermal cues contribute a significant additional effect to the elicitation of strikes. Incidentally, visual plus thermal cues. (i.e., 38°C) were successful in producing strikes in 63 of 63 trials, suggesting that other cues (e.g., chemical ones) were unnecessary in our situation.

The occurrence of a predatory strike was not a guarantee that a high level of SICS would follow (Scudder 1982). The level seen after strikes to warm models was near the levels we have seen in similar experiments in which rodents were struck; but, the level seen after strikes to cool targets was much lower, though not zero. This suggests that the the decision to strike does not determine completely the decision to search. If this had been the case, then predatory strikes to cool models should have been followed by full-intensity SICS. We conclude that a second decision occurs during or after the strike, and this decision governs the magnitude of SICS. A very different argument, based on path analytic techniques, led to essentially the same conclusion (Chiszar *et al.*, 1988). It might appear puzzling that thermal cues increase the probability of striking and we also hold that they enhance SICS at a later point in time. That the same stimulus influences two separate decisions need not be a source of concern, especially if snakes execute temporally separate samplings of the stimulus. It is, of course, also possible that a single sampling could occur prior to the strike, with memory serving to keep thermal data available for later use. Although we do not discount the existence of thermal memory, there is good reason to believe that thermal cues are sampled twice, first with pits prior to the strike and second with pits and/or intraoral receptors. The later are certain to be stimulated during contact with prey (Dickman *et al.*, 1987).

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THE STATUS OF *CNEMIDOPHORUS TIGRIS RETICULORIENS* VANCE, 1978 (REPTILIA: LACERTILIA)

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Abstract

The authorship of *Cnemidophorus tigris reticuloriens* is discussed. Described as a new taxon by Hendricks in a 1975 dissertation, the name and diagnostic features were incorporated into a field key by Vance in 1978; however, Hendricks and Dixon formally presented the taxon in 1986 as *C. marmoratus reticuloriens*. A request to the International Commission of Zoological Nomenclature to suppress Vance as the authority and to add the subspecific name used by Vance to the Official Index of Rejected and Invalid Specific Names in Zoology was denied. An explanation is warranted in order to clarify this taxonomic problem.

The accessibility of a doctoral dissertation (Hendricks, 1975) in which two new subspecies of *Cnemidophorus tigris* Baird & Girard, 1852, were described led one of us (Vance, 1978) unwittingly to make one of those names available in a brief synoptic key and distributional account of all species and subspecies of *Cnemidophorus* in the United States. With the recent proper proposal of the name (Hendricks and Dixon, 1986), consideration of actual authorship and date of publication is necessary.

The two new names incorporated in Hendrick's dissertation (1975) were *Cnemidophorus tigris reticuloriens* and *C. t. nigroriens*. Both were published as new (Hendricks and Dixon, 1986) in the combinations *Cnemidophorus marmoratus reticuloriens* and *C. m. nigroriens*.

However, Vance in 1978 included the name *Cnemidophorus tigris reticuloriens* in his key (p. 3) to the U.S. taxa of the genus, mapped its distribution (Fig. 2, p. 5) and (p. 1) attributed the name to Hendricks. By providing key characters for the subspecies he clearly complied with the most critical requirement for availability of names published after 1930 (Art. 13), and since the characterization of the taxon was obviously his own, even though the name was attributed to Hendricks, Vance is formally its author.

On the other hand, Vance was definitely unaware that his 1978 actions made the subspecific name *reticuloriens* available with his authorship. When so discovered, he scrupulously avoided citing Hendricks' other new name, *nigroriens*, in his later review (1980) of the Mexican taxa of *Cnemidophorus*, although he included its subspecies in his key (p. 134) and maps (Fig. 4, p. 136) under the name *Cnemidophorus tigris* "sub. sp." In that work (p. 122) Vance disclaimed "formal taxonomic validity" of his use in 1978 of the subspecific name *reticuloriens*, but that disclaimer came ex post facto; had it accompanied his 1978 work, it might possibly be accepted as an extrapolation from Art. 8(b) of the Code, which rejects any work containing "a disclaimer that it is issued for permanent scientific record." Further noting that nevertheless at least two publications maintained in principle that his usage of *reticuloriens* made the name available as of his authorship, he concluded that "a ruling concerning this problem is much to be desired."

In reality the Code clearly covers the situation: *C. t. reticuloriens* Vance 1978, is an available name antedating *C. m. reticuloriens* Hendricks and Dixon, 1986. It is nevertheless true that zoologists should be more familiar with the Code than they are. When alpha taxonomy was the dominant endeavor in zoology, familiarity with nomenclatural protocol was more common than it is today, quite understandably in view of the tremendous advances that have been made in many other fields. Awareness however of the importance of maintenance of a universal system of nomenclature, requiring rules that virtually all workers respect, is as vital now as its was in the infancy of scientific endeavor.

In the present case, it at first seemed simply a matter of seeking rectification of an innocent error, since the Code might be considered to provide the means of correction, under Art. 79, through the plenary powers of the International Commission on Zoological Nomenclature.

We therefore requested the Commission (a) to suppress the subspecific name *reticuloriens*, as used in the combination *Cnemidophorus tigris reticuloriens*, Vance, 1978, for purposes of both the Principle of Priority and the Principle of Homonymy; and (b) to add that subspecific name, used in that combination by that author as of that date, to the Official Index of Rejected and Invalid Specific Names in Zoology.

To our dismay, however, it appears that no rectification can be made, as stated in the response received from the Secretary of the Commission, Dr. Philip K. Tubbs, to our petition:

> "I am sorry, but quite understand, that you feel strongly about the name *reticuloriens*. The problems is that this name indisputedly has the date of 1978, since in Vance's paper it was published with a characterization of the species (and a distribution

map). It is of course true that on p. 1 it was mentioned as *reticuloriens* Hendricks, just as other (previously published) names were followed by Cope, Linnaeus, etc., but the name was made available by Vance.

"A fuller description etc. of the taxon has now, years later, been published by Hendricks & Dixon (1986), and for taxonomic purposes of course this should be cited. I should point out that the authorship is not strictly part of the name (cf. Article 51a of the Code), but is in effect for bibliographic purposes; the date determines its precedence over synonyms. Suppose the ICZN were to suppress *reticuloriens* Vance, 1978: then citations of that (or any synonym) in say 1979-1985 would still have priority over *reticuloriens* Hendricks & Dixon, 1986. The latter is *not* a 'new' name, as a matter of (unfortunate) historical fact.

"As I am sure you will realize, the ICZN would very frequently be in an impossible position if it suppressed perfectly valid (in this objective sense) names, simply to give 'credit' to authors. This is especially true after eight years! The Commission exists to stabilize the names of taxa, not authors, and *except to do that* cannot 'suppress' past history. *I have taken various soundings* [our italics], and can assure you that suppression of the 1978 *reticuloriens* would not be accepted. I must say I agree with this; of course I sympathize with Hendricks, but much worse happens!

"The other cases you mention are not strictly comparable: your *Palmatotriton* was not published as a scientific name (Opinion 425). In the case of Opinion 1343 (*Kinosternon [alamosae* and *oaxacae]*) the definitive later works were cited in the work which inadvertently appeared earlier (by a few months).

"I hope that on reflection you and Drs. Hendricks and Vance will agree, with natural reluctance, that the ICZN really cannot do anything about the date of *reticuloriens*."

The conclusion we are left with is that, despite our objection [*in litt.* to ICZN] and unanimous disapproval, the name of the subspecies in question is officially decreed to be properly cited as *Cnemidophorus marmoratus reticuloriens* Vance, 1978, under the Code, and under Commission consideration.

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DISTRIBUTIONAL ADDENDA FOR THE SMOOTH GREEN SNAKE (*OPHEODRYS VERNALIS*) IN WESTERN COLORADO, AND THE STATUS OF ITS SUBSPECIES

Hobart M. Smith, Geoffrey A. Hammerson, Jan J. Roth, and
David Chiszar

Abstract

Four new county records of *Opheodrys vernalis* in Colorado extend the western peripheries of the known range of the species. The material conforms with the subspecific distinctions of *O. v. blanchardi*, as expected on geographic grounds. The difference between the two subspecies conventionally recognized is not subject to confounding clinal variation, as has been claimed. Variation in number of ventrals in *any* given case may or may not be confusingly clinal; each case merits individual evaluation. If the variation is geographic and essentially non-clinal, subspecific recognition is likely to be justified, as it is in the case of *O. v. vernalis* and *O. v. blanchardi*.

Documentation recently acquired by the University of Colorado Museum (CUM), mostly through the efforts of two of us (GAH, JJR), adds four new county records for *Opheodrys vernalis blanchardi* Grobman to those apparent in Hammerson's (1982) survey of the herpetology of Colorado. Variational data derived from the specimens represented in that documentation permit a comparison with comparable data that have been interpreted as precluding recognition of subspecies of the smooth green snake.

Material

The materials on which the new county records are based are as follows, given more or less in south-north order.

Gunnison Co. A flattened, dry DOR specimen (56227) was found by one of us (GAH) 6.5 km E Somerset, 30 June 1990.

Delta Co. One battered specimen (56185) in alcohol is from 6.5 km S Cedaredge, taken 7 June 1986 by L. Valentine.

Rio Blanco Co. A photograph now on deposit in CUM documents one example found by one of us (GAH) freshly DOR 8 km E and 3.2 km S Meeker (center), 14 August 1989.

Moffat Co. The earliest documentation for this county is a photograph taken by GAH, now deposited in CUM of an individual found freshly DOR 1.2 km W and 4.8 km S Freeman Reservoir, 13 August 1989. In the summer of 1990 JJR obtained four specimens, now in alcohol, as follows: 56236, 23 km N Craig on CO 13, then 3.2 km E, 8 July; 56237-9, 16 km SW Hamilton on Co 13, then 3.2 km S, 10 July. One other example, a juvenile presumably hatched the previous year, was caught with the latter three, but apparently was eaten by one of them while all were kept for two months in a single cage. On 30 June two others were seen and released; one was 6.5 km S Slater, near Slater Creek, and the other 13 km E Craig, near Elkhead Creek. These records are some 70 km west of previously recorded limits (Hammerson, 1982) in Routt Co., and probably very near the actual western limit of the range of the species in that area (fig. 1). Semiarid conditions westward from only a few km west of present records of occurrence presumably preclude its presence there.

One female (56236) s-v 260 mm, tl 369 mm, contained 5 large eggs, 20-27 mm in length, 9 mm in diameter. No embryonic development was evident in one dissected egg, although at 8 July, when captured (DOR), considerable development would be expected inasmuch as oviposition should occur in August, with such advanced embryos that they should hatch in early September (Blanchard, 1933; H. M. Smith, 1963). A larger female (56237), 308 mm s-v, 525 mm tl, taken only two days later, contained no eggs. The three males measured 228, 233 and 285 mm sv, tl 345, 350 and 424 mm respectively. Although the species reaches a maximum total length of 660 mm (Conant 1975: 185), the 525 mm female may well be the largest reported of western *O. v. blanchardi*, which appears to be somewhat smaller than the nominotypical subspecies or eastern *O. v. blanchardi*. On the other hand, even western *O. v. vernalis*, isolated in the Black Hills area, is likewise small; in over 100 specimens reported from that area, the largest male measured 446 mm in total length, the largest female 464 mm (Peterson, 1974: 36). Eastern *O. v. blanchardi* reaches a total length of at least 565 mm in Illinois (P. W. Smith, 1961: 194)

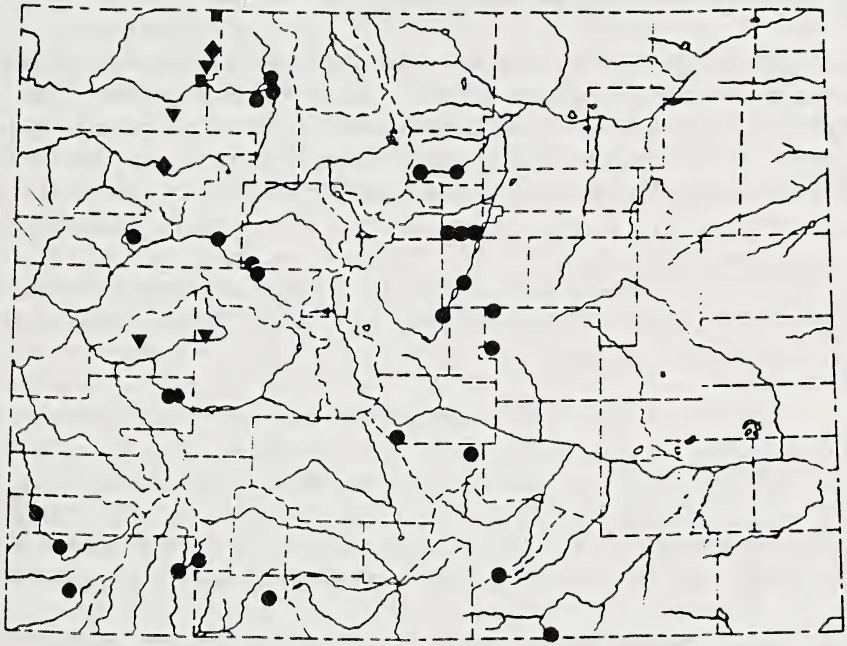

Fig. 1. Localities of record in Colorado for *Opheodrys vernalis blanchardi*, adapted from Hammerson (1982:98). Circular dots, localities of previous record, as given in Hammerson (loc. cit.); all others are for present records: triangular dots, localities represented by voucher specimens; diamonds, localities represented by voucher photographs; square dots, sight records.

Subspecific Allocation

The five voucher specimens on which ventral counts can be made (four from Moffat Co., one from Delta Co.) are of interest not only as range extensions and county records, but also in their bearing upon the concept of subspecies in their species. The conclusion by the specialists consulted in preparation of the latest edition of the North American herpetofaunal common names list (Collins, 1990:2) was that the two subspecies formerly recognized of *Opheodrys vernalis* are not tenable because they are based on clinal variation in number of ventral scales.

The present specimens, however, do conform with variational expectation of the western subspecies *O. v. blanchardi* Grobman. Two females (56236-7) have 139 and 150 ventrals; most females of the eastern subspecies have 139 or fewer ventrals, only 12 (4.2%) of the 287 counts recorded by Grobman (1941) and H. M. Smith (1963) being more than 138. Furthermore, neither author recorded any count for *O. v. vernalis* over 144, whereas *O. v. blanchardi* has a range of 139-154 (n = 31) (Grobman, 1941). Obviously the present westernmost specimens do not suggest that they fit into a cline, for one has a minimal count that would be expected only on the eastern edge of the range of the subspecies.

The three males (56185, 56238-9) have 132, 136 and 137 ventrals, modal numbers for *O. v. blanchardi*, with a range of 125-141, whereas only three (1.3%) of the 224 counts in Grobman (1941) and H. M. Smith (1963) for the nominotypical race exceed 130. The Moffat Co. specimens fall in the middle of the range of *O. v. blanchardi*, not near the upper end of its range as would be the case if the variation in the species were clinal, east to west.

Caudal counts do not discriminate between the two supposed races, hence are irrelevant in present contexts, except to note that those of the present specimens fall within previously established limits for their subspecies.

The only criterion Grobman (1941) found that distinguishes the eastern and western races of *O. vernalis* is the number of ventrals, but a major difference exists in that context: in females, 96% of the eastern race (*O. v. vernalis*) have 139 or fewer and 91% of the western subspecies (*O. v. blanchardi*) have 140 or more; and in males, 99% of the eastern have 130 or fewer, and 94% of the western have 131 or more.

These figures do not suggest that clinal variation exists in *Opheodrys vernalis* from east to west, the vector in which the two races are distinguished. Indeed, Grobman (1941) explicitly analyzed his data for geographic clines, and found them in the north-south vector, in which clines in number of segments (reflected by numbers of caudals and ventrals), are to be expected in correlation with temperature clines. There is no temperature cline on the east-west axis; there is, on the contrary, a rather sharp humidity gradient now more or less coincident with the eastern edge of the Great Plains, and in Holocene times probably extending through the Prairie Peninsula south of the Great Lakes (P.W. Smith, 1957). The eastern edge of the range of *O. v. blanchardi* conforms reasonably well with that gradient.

Peterson (1974: 37) nevertheless concluded on the basis of 76 specimens he obtained in the Black Hills, Robins' (1952) series of 13 and H. M. Smith's (1963) series of 40 from the same area, contrary to Grobman (1941) and H. M. Smith (1963), that, "Because the distinction between subspecies of *Opheodrys vernalis* is based on minor differences in average counts of a character strongly influenced by environmental conditions (especially temperature), it is recommended that subspecies of this snake not be recognized."

That conclusion rests upon the assumptions that (1) minor differences are suspect and, implicitly, that (2) in this case they are not genetically fixed, as well as upon (3) such a supposedly distinct intermediacy of the Black Hills population that it does not conform with the criteria proposed by Grobman for separation of the two subspecies.

None of those objections are tenable. First, whether phenotypic differences are major or minor is immaterial in taxonomic contexts; their significance lies solely in their dependence, or not, upon a degree of genetic fixation that permits distinction of populations uniformly over considerable geographic areas, with relatively narrow zones of intergradation. Secondly, genetic fixation of the difference detected in ventral counts is strongly implied by the constancy of the different variational limits of each subspecies, despite wide variation in temperature and humidity, north-south and east-west respectively, within the geographic range of each.

Finally, although it is definitely true that the mean ventral numbers given in each of the three Black Hills samples cited by Peterson (1974; table 8) (his own, Robins 1952, H. M. Smith 1963) are skewed slightly toward the means for *O. v. blanchardi*, and away from those for *O. v. vernalis*, as given by Grobman (1941), 93% of the 72 males reported by all sources, and 82% of the 55 females, fall within the limits established (Grobman, 1941 and in prep.) for *O. v. vernalis*.

It seems likely that the skewness exhibited by the Black Hills population is a result of introgression from *O. v. blanchardi*, occurring as the eastern subspecies retreated with development of the Prairie Peninsula (P. W. Smith, 1957).

We accordingly conclude that validity of the subspecies of *O. vernalis* detected by Grobman (1941) cannot with reason be denied on the basis of clinal variation, for none exists that is correlated with the diagnostic features of the two races. The distinguishing character states hold relatively constant throughout the range of each subspecies, with a typically narrow zone of intergradation between, despite great variation in temperatures within each range.

The long-term stability of the distinction between these two races is, indeed, documented by the persistance of *O. v. blanchardi* in the now largely historical Prairie Peninsula despite Holocene climatic changes, and by the persistence of *O. v. vernalis* in the Black Hills where the climate to which it is adapted also persists, whereas *O. v. blanchardi* occupied the surrounding plains that became more xeric - conditions to which it is adapted.

Failure to recognize the two subspecies of *O. vernalis* clouds the long independent evolutionary history both obviously have had, over several thousand or even tens of thousands of years, and the complex present biogeography explained by that history. These races are equally as well defined as, or better than, those of, for example, *Coluber constrictor, Elaphe guttata, E. obsoleta* and *E. vulpina* - all based largely on color or minor pattern variants, and widely accepted. Ever since the direct environmental, non-genetic effect of temperature on segmental numbers in snakes was discovered, character states involving ventral and caudal counts have been suspect, readily dismissed as non-genetic or strictly clinal, without proper evaluation. In addition, a character requiring such tedious examination as segmental numbers engenders a negative bias vis-a-vis characters (such as color or pattern characteristics) that can be appraised at a glance or at least without optical magnification.

The number of ventrals or caudals obviously is susceptible to correlation non-genetically with clines of temperature, but it can also be genetically selected for adaptation to other environmental factors that are relatively constant over wide regions. Each case merits individual evaluation, when segmental numbers are involved in taxonomic distinctions; it should not be assumed axiomatically that all are invalid on clinal grounds that in reality may or may not exist. It is an easy but totally unjustified assumption to make. Properly screened to eliminate clinal variation (which may be genetic or not), segmental character-states are just as valid as criteria of taxonomic entities as color, pattern variants or other phenotypic expressions of genetic differentiation.

Acknowledgments

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OVIPOSITION OF *ACANTHOCHELYS PALLIDIPECTORIS* (FREIBERG) IN CAPTIVITY (CHELONII: CHELIDAE)

Acanthochelys pallidipectoris was defined as "an apparently extremely rare species from a very limited geographic range centered in the Argentinian and Paraguayan Chaco" (Rhodin, 1982). Very little data has been recorded on the biology of this species (Ernst, 1983; Mertens, 1954 and Waller, 1988). This note reports an observation on oviposition in this turtle.

An adult female (straight carapace length 159 mm, plastron length 136 mm., width 116 mm, shell height 41 mm and weight 400 g) of *A. pallidipectoris* was collected on 12 August 1990 (Alto Verde's lagoons: Dpto Junin, Mendoza, Argentina) and kept in captivity in a home-made tank. A wide variety of insects (Orthoptera, Hemiptera, Coleoptera, Lepidoptera and Diptera), molluscs (*Physa* sp and *Planorbis* sp), tadpoles (*Pleurodema tucumana*), poeciliid fishes (*Jenynsia lineata*) (all alive) and meat, were offered as food items but only tadpoles (length 10 - 30 mm), fishes length 20 - 30 mm) and meat were accepted. On 26 September 1990, the specimen deposited five eggs in the water of the tank. They were pinkish-white (Color 3B1: Maerz and Paul, 1950) with white points dispersed on all egg surfaces. These eggs are brittle-shelled and all were recovered in perfect condition. Their size and weight are:

Length (mm)	Width (mm)	Weight (g)
25.1	24.0	9.0
24.5	23.7	8.6
24.5	23.6	8.5
25.5	24.1	9.1
24.4	23.9	9.0

In Argentina, *A. pallidipectoris* inhabits temporary lagoons (rainy season) in the Chacoan region of the following province: Chaco, Formosa, Salta, Santa Fe (Richard et al, 1990) and in the Monte region of Mendoza (this note). In Paraguay, this species was reported in the Apalue locality, but this record has yet to be substantiated (Ernst, 1983; Waller, 1988).

A. pallidipectoris is included under the category of Rare species of the International Union for Conservation of Nature and Natural Resources (Stubbs, 1989).

The specimen mentioned in this note is in the Acuario Municipal de Mendoza (Argentina). The eggs of this turtle will be deposited in the Herpetological Collection of the Instituto de Herpetología, Fundación Miguel Lillo (Tucumán, Argentina).

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While this handbook includes entries for living crocodilian species, a special emphasis has been placed on the American alligator and crocodile.

The text is complemented by nearly 100 line drawings and maps, specially commissioned for this book. Among the areas covered are detailed, anatomically correct drawings of crocodilian structure, prey attack, capture and feeding behaviors, and various aquatic profiles, as well as terrestrial gaits and new range maps based on the very latest available data. An illustrated key to the species based on nuchal and post-occipital scalation is also included. The bibliography contains over 500 cited and non-cited references on living crocodilians, which alone makes this book a valuable tool for researchers seeking additional information.

With respect to the American alligator, in addition to a general entry, there are 10 separate state entries including the latest information on range, population, nuisance, and other human-interaction statistics. Detailed information on alligator habitats are included under individual state entries, when warranted. Management programs are also discussed where they've been put into effect.

With regard to the American crocodile, its U.S. and extraterritorial ranges are documented from the most recent data available. The American Crocodile Recovery Plan from the U.S. Fish and Wildlife Service is reprinted verbatim, together with commentary. A special discussion concerning the crocodile population at the Turkey Point Nuclear Power Plant is also included.

In addition, there are separate entries for all other living crocodilians, which include range maps, geographic locations, scientific and common name(s), habitat, feeding characteristics, reproductive behaviors and data, when known, and a general commentary. Disputes in the literature regarding the validity of some classifications other than those established are reported.

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About the Author:

Steve Grenard is a cardiopulmonary physiologist, registered respiratory therapist, professional herpetologist and medical/science writer. He is the author of 7 published books in science and medicine and hundreds of articles. He's been studying crocodilians for more than 25 years.

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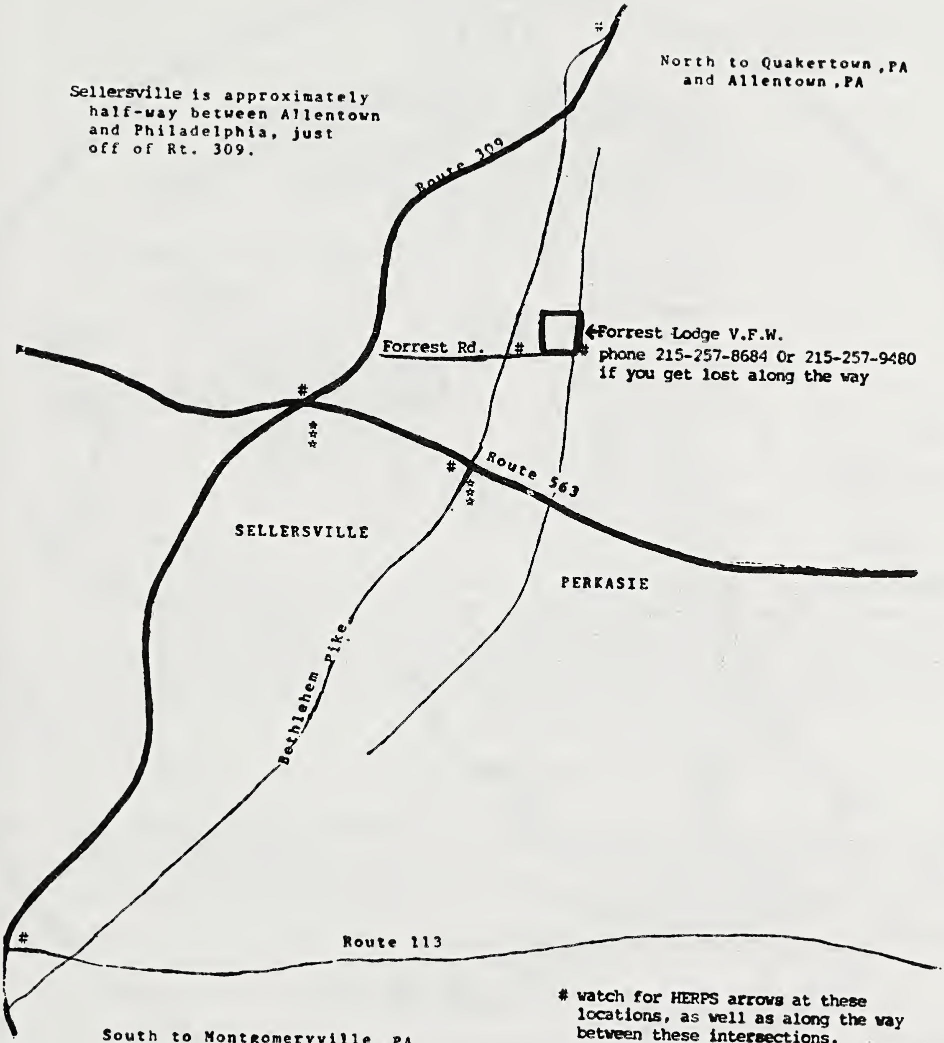

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Editor's note:

Due to the Gulf War, the proof of M.K. Al-Sadoon et al. published in the March 91 issue (page 1-22) was received too late to include corrections. The following corrections were received 5/9/91 from the author.

-page 1, line 2 of Abstract
should read "...species of lizards belonging to 5 families, a single species of amphisbaenians...

-page 2, 3rd paragraph, line 2
should read sand instead of Sand

-page 3, 2nd paragraph. line 7
should read "...lot of damage..."

-page 3, 4th line up from bottom
(*Pseudotrapelues*) should be (*Pseudotrapelus*)

-page 7, 3rd line up from bottom
"...represented..."

-page 8, 7th paragraph
Jayaker's should read Jayakar's

-page 9
Malpolon molilensis should read *Malpolon moilensis*

-page 9, 7th paragraph
Burayman should read Buraydah

-page 21, last entry
Walterinesia should read *Walterinnesia*

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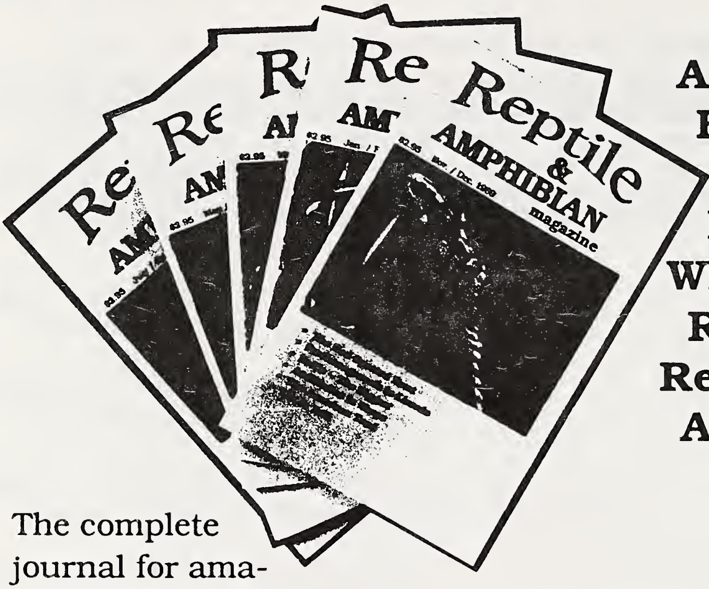

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Volume 27 Number 3 September 1991

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Volume 27 Number 3 September 1991

THE CORRECT SPELLING OF THE NAME FOR THE SHORT-HORNED LIZARD OF NORTH AMERICA

Geoffrey A. Hammerson and Hobart M. Smith

Abstract

Because Bell, in describing *Agama douglassii*, also used the spelling *A. douglasii*, and because no previous choice between the two spellings has been published in conformance with Art. 24 of the Code, we hereby select, under the authority of Arts. 24 and 32 of the Code, the spelling *Agama douglasii* as correct; the name therefore currently stands as *Phrynosoma douglasii* (Bell), which we render as *P. douglasi* in accordance with the 1990 ICZN action. The spelling "*douglassii*" thereby becomes an "incorrect original spelling" and has "no separate availability in the original form, and cannot, in that form, enter into homonymy or be used as a replacement name."

David Douglas, 1799-1834, a famed British botanical explorer and collector who made many new discoveries in the United States, Canada and Hawaii, and especially in northwestern United States, and who is honored by several patronyms, formal and informal (e.g. Douglas-fir), for both plants and animals, had a species of horned lizard, of which he sent two specimens (fide Boulenger, 1885: 241) to England, named for him by Thomas Bell in 1828 (date fide Collins, 1990: 22). Unfortunately, Bell misspelled Douglas' name in the title of his article and three times in the text, although he identified him once as "Mr. David Douglass." In addition, he spelled his new species name "*Agama douglassii*" in his formal description (p. 105). However, the name given on the figures (pl. 10) is spelled "*Agama Douglasii*". There are, accordingly, two original spellings, concerning which the Code states (Art. 32(b)(i)) "If a name is spelled in more than one way in the work in which it was established, then, subject to Section c of the Article, the correct original spelling is that chosen by the first reviser [Art. 24c]." Section c merely makes plain that an original spelling not adopted by the first reviser is an "incorrect original spelling." Section d of the same Article states that an incorrect original spelling "has no separate availability", "cannot enter into homonymy" and cannot "be used as a replacement name."

Article 24 explains that the "first reviser" is the first author who cites all original spellings together, and for whatever reason explicitly chooses one as the valid name.

Many authors, of course, have used the specific name *douglasii* or *douglassii*, but none have ever cited both spellings. (In conformance with the arguments of Dundee and Smith (1989) and with the decision to accept (Savage, 1990), in the new edition of the Code now in preparation, either ending, -i, or -ii, as admissible regardless of the original spelling, we here adopt the single -i ending for Bell's specific name.)

Holbrook (1838: 69, pl. 12) correctly spelled David Douglas both times the name was used, once even in a quotation from Bell (1828), correcting Bell's misspelling; however he still spelled the specific name *douglassii*. DeKay (1842: 31) was the first after Bell to spell the name with a single s, and Gray (1845: 227) did the same, adding the common name of "Douglas's Phrynosoma". Baird (1859: 9) also used one s but all other citations in his synonymy, to works by Bell, Holbrook and Girard, were given with one s, whereas all of them actually used a double s. Bocourt (1874) used the double s in the text (p. 226), but a single s appears with plate 11. Stejneger (1890: 112) used a double s for the specific name, a single s for the subspecific name. Cope (1900: 409) used a single s for the species account, but the double s for all following subspecies accounts. All other works of which we are aware, before and after 1900, including the most recent monograph of the genus (Reeve, 1952), adopted the spelling with a double s.

Clearly no "first reviser" choice has ever been made between the two original spellings; no synonymy or discussion has cited *both* spellings by Bell - only one or the other. Our selection here, according to the Code, constitutes the "first reviser" choice of the correct spelling.

Each of the two alternatives has its merits and demerits. Obviously the most compelling precept of the Code is maintenance of stability of nomenclature, and since the spelling *douglasi* has not been used for 90 years, it would seem best to maintain the long-accustomed spelling *douglassi*.

On the other hand, the specific name may with some justification be regarded as the same regardless of these particular differences in spelling (although those differences are not listed in Art. 28 on variant spellings deemed to be identical in homonymy), hence stability of *name* is not threatened. In addition, David Douglas was such a very famous figure in early natural history exploration, particularly in botany (Morwood, 1973), that it would be a travesty to perpetuate the misspelling of his surname and patronym as understood in error by Bell (1828). Of course authors of the 19th century seemed to be somewhat casual in discrimination between spellings with a single or double s. However, there is no evidence that Douglas himself, or his family, was inconsistent in use of a single s.

We are both strongly - perhaps even fanatically - supportive of the Code's precept of maintenance of nomenclatural stability, but in this case we do not regard selection of the single s spelling as an affront to stability, because the *basic* name remains the same. Had the collector not been such an outstanding figure in the history of biological exploration we would perhaps choose the long-adopted spelling instead. But in view of his stature, we would reason that the change to a single s spelling would be justified even in its absence as an original spelling, on the basis simply of an obvious error on the part of the original author.

Fortunately we do not operate at the extremity, and therefore here exercise our powers as joint first revisers to select the spelling *douglasi*, as used in the combination *Agama douglasii* by Bell (1828) as the correct original spelling of the name. The spelling *Agama douglassii* thereby becomes an invalid, nomenclaturally non-existent, "incorrect original spelling". The earliest usages of the correct spellings for the several taxa involved, as commonly recognized, are as follows:

Phrynosoma douglasi (Bell, 1828) (DeKay, 1842)

P. d. brachycercum Smith, 1942 (nobis)

P. d. brevirostre (Girard, 1858) (nobis)

P. d. douglasi (Bell, 1828) (nobis)

P. d. hernandezi (Girard, 1858) (nobis; the original spelling, with an *s* instead of a *z*, is incorrect)

P. d. ornatissimum (Girard, 1858) (nobis)

P. d. ornatum Girard, 1858 (nobis)

Acknowledgment

We are much indebted to Dr. Jane Bock for guidance in botanical literature.

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Appendix

David Douglas appears to be little known among zoologists, although extensively memorialized by botanists and horticulturists. A brief review here of his dynamic career and bizarre end may thus be useful (drawn from Morwood, 1973). He was born in 1799 in Scone, Scotland, which he claimed as home throughout his short life of 35 years. He was a rebellious student and early dropout from school, but his native intelligence and curiosity flourished under informal circumstances. Gardening appealed to him, and soon he was an apt apprentice in various formal gardens, ultimately at Glasgow University where the legendary botanist William Jackson Hooker took him under his wing. Through his association Douglas became a skilled and indefatigable plant collector of both propagative and herbarium material. Upon Hooker's recommendation, the Horticultural Society sent Douglas in 1823 to southeastern Canada and adjacent United States to collect for them. His success was phenomenal, and he was heaped with praise as he returned to London later that year.

Hudson's Bay Company, in an effort to cement its hold on the Pacific Northwest, collaborated with the Horticultural Society to send Douglas there, 1824 to 1827. Travelling by boat around Cape Horn, he botanized in the Juan Fernández and Galapagos islands, arriving at the mouth of the Columbia River in 1825, eight months after leaving England. For the rest of that year, and through 1826, he radiated widely from his headquarters at Fort Vancouver, over primitive terrain under extreme privations, winter and summer, exploring, collecting and shipping plants (and the specimens of horned lizards) back to England in overwhelming quantities. In early 1827 he headed back to England, 3000 miles across southern Canada, arriving in London late that year.

He was received there with even greater acclaim than before. However, the lack of technical training, and his origin from the labor class, sorely frustrated his ambitions to publish his journal and to report scientifically on his collections. He was inordinately shy anyway, wanting in self-confidence, and as a result began to drift in ineffectuality, until rescued in 1829 by still another offer by the Horticultural Society to send him again to the Pacific coast of America. He gave all of his collections (which he had until then jealously guarded for his own study that never materialized) to Hooker, and after a few weeks of indoctrination into the use of a wide variety of surveying instruments (for the Colonial Office wanted more precise mapping of the area north of Baja California) he sailed again to the west coast of America.

There he collected and shipped material back to London, from southern and central California, from 1830 to 1832. Then he returned to his old haunts in northwestern U.S., collecting through 1833 there and farther north into Canada than he had gone before. He hoped to go to Siberia, but as time passed without materialization of the dream, he took the opportunity to sail to Hawaii in early 1834.

There the saga of David Douglas ends in a mystery that remains unsolved. He continued collecting as assiduously as ever, after his arrival on Jan. 2. On the island of Hawaii, July 12, 1834, while walking along on an estate where he was housed temporarily, he fell into a small pit-trap that had previously caught a wandering bull, and was there trampled to death. Whether it was an act of suicide or accident remains unknown, and always will. It could have been either, for he was confused and despondent, but he also reputedly had a deathly fear of bulls. It could have been murder, for, as Jaeger (1955: 311) states, "suspicious natives" may have tossed him into the pit-trap.

Douglas never married so his name lives on through his many discoveries, including some 300 plant species of western North America. Dozens of plants bear his eponym, he named numerous others himself, and the Douglas-fir, Douglas' squirrel (*Tamiasciurus douglasi* (Bachman), which he collected) and Mt. Douglas (11,017 ft) of the Canadian Rocky Mountains bear his name. The mountain was one he climbed on his return to London across southern Canada in 1827; two he named for his mentors - Mt. Brown and Mt. Hooker. Several monuments to him have been erected in Scotland.

It is most fitting that the only reptile collected by David Douglas, and named for him, should bear his name properly spelled, as are all others honoring him.

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PERIPHERAL VARIATION IN THE LIZARD *SCELOPORUS OLIVACEUS*, AND ITS HYBRIDIZATION WITH *S. UNDULATUS*

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Abstract

Four extraordinary variations are recorded in sympatric populations of *Sceloporus olivaceus* and *S. undulatus* in western Texas. Two of the variations, in *S. undulatus*, appear to have resulted from introgression sourced from hybridization with *S. olivaceus*. We think it likely that hybridization occurred only between male *S. olivaceus* and female *S. u. consobrinus*, not the reciprocal way. The other two variants, occurring in *S. olivaceus*, appear to be manifestations of the existence of a genetic potential evoked by the different selection pressures exerted on these and other peripheral, as opposed to central, populations. The response in this case to different peripheral pressures is thus not reduced variability, as is often to be expected, but increased and different variability.

Study of four specimens of *Sceloporus undulatus consobrinus* Baird and Girard collected 48 years ago, and of four *S. olivaceus* Smith that the earlier series recently stimulated us to collect near the source of the other four, has revealed an astonishing array of hitherto unreported variations of fascinating origin.

Material

The primary material on which our study has focussed is in the University of Colorado museum, and includes *S. u. consobrinus*, CUM 7939-42, from 32.2 km NW San Angel, Tom Green Co., Texas, taken April 5, 1952, by T. Paul Maslin and William K. Davis; and *S. olivaceus*, CUM 56230-3, from southern Coke Co., Texas, 4.8 km N Water Valley, Tom Green Co., taken Aug. 14-15, 1990, by the present authors.

The Variants in *S. u. consobrinus*

One female (7940) and three males (7939, 7941-42) are represented in the Tom Green Co. series. The female is the largest, 60 mm s-v, and the males vary from 51 to 55 mm s-v. The males have large blue, black-bordered, abdominal and gular semeions, and all of both sexes fall well within the size range for mature adults as indicated in Vermersch (1991) for central Texas populations. The dorsals are 35, 38, and 40 in males , 37 in the female, the scales between the two femoral pore series are 4 or 5 in the males, 6 in the female, and the femoral pores are 13(3), 14(3), or 15(2). The interfemoral scale count is typical, the subspecies as a whole having a mean of 4.9 (Smith, 1938), but both the dorsal scale and the femoral pore counts are low for the subspecies, in which the dorsal scale count mean is 40.2, and the femoral pore count mean 16.2. In each of the latter two characters the Tom Green series approaches the means for *S. olivaceus* (means 29.8 and 13.3, respectively; Smith, 1939).

The head scales of the Tom Green Co. *S. u. consobrinus* are all normal for the subspecies, and the series of small scales here termed the oculofrontoparietals, between the supraoculars and median head scales, is complete and uninterrupted on both sides, as expected, except in the female. In that specimen, the four posterior of the six large, strap-like, undivided supraoculars are broadly in contact with the median head scales; the oculofrontoparietals are completely absent between the anterior end of the 3rd supraocular and the posterior end of the 6th (Fig. 1). This condition is clearly evident on the left side; although the right side is damaged, it appears to be the same, all rear supraoculars being in contact with median head scales and the intervening small scales completely absent, as on the left side.

Such a condition is completely unheard-of in any member of either the *undulatus* group or its derivative, *S. graciosus*. It is, however, characteristic of almost all members of the *spinosus* group. Of great significance is the fact that the primary exceptions to the rule of an extensively incomplete series of oculofrontoparietals in members of the *spinosus* group are *S. cautus* and *S. olivaceus*, both long-recognized (Smith, 1939; Larson and Tanner, 1974) as of close common ancestry with the *undulatus* group. The genetic factors responsible for the broadly interrupted oculofrontoparietals in mainstream members of the *spinosus* group no longer are operative in its derived members, *S. olivaceus* and *S. cautus*, or in the *undulatus* and *graciosus* groups that apparently were derived from the *S. olivaceus*/*S. cautus* branch (Cole, 1970, 1972).

We hypothesize that the grossly aberrant oculofrontoparietal condition in 7940 is a product of hybridization with and introgression from *S.*

olivaceus, the only obvious vehicle for the variation. Even though *S. olivaceus* is not known to exhibit such a condition, its ancestors presumably did. Rather than having eliminated the genetic capacity to express that condition, suppressor genes apparently evolved that have prevented its expression throughout that evolutionary line, at least in company with the normal specific genomes. However, we postulate that in a hybrid genome, as in the present case, the suppressor effect does not always occur, for whatever reason.

The suspicion, arising from the oculofrontoparietal aberration, of occurrence of hybridization between *S. olivaceus* and *S. u. consobrinus* and resultant introgression of *S. olivaceus* genes into the *S. u. consobrinus* genome, at least in the indicated area of Texas, is strengthened somewhat by the low dorsal and femoral pore counts of the Tom Green Co. series, because those counts approach the means for *S. olivaceus*. A clinching aberration involves the dorsal pattern especially of the female, but also, to a lesser extent, of the males of *S. u. consobrinus* (Fig. 2). In dorsal pattern the female so closely resembles *S. olivaceus* that it could easily be mistaken (and has been) for the latter species. The undulate dark crossbars so widely characteristic of members of the *undulatus* and *graciosus* groups, as well as of *S. olivaceus*, are characteristically limited to the lateral edges of the broad vertebral, pigmented area in *S. u. consobrinus*, not crossing the conspicuous dorsolateral light lines, one on each side (Fig. 3). In females of all sizes (Fig. 4) and in young males of *S. olivaceus*, the undulate dark crossbars interrupt the dorsolateral light lines, which are scarcely discernible, although they become more prominent in males as they mature, the dark crossbars tending to disappear with but few vestiges (Fig. 4).

Hybridization between *S. olivaceus* and *S. u. consobrinus* has not been recorded elsewhere, although the latter subspecies occurs throughout most of the range of the former species (Figs. 5, 6). Nevertheless the situation in the study area may well be regarded as conducive to interbreeding because the two taxa there occupy habitats more intimately interdigitating than in most other parts of the range of *S. olivaceus*. As noted by Mayr (1963: 128), "By far the most frequent cause of hybridization in animals is the breakdown of habitat barriers, ..." whether man-made or not. Tom Green and Coke counties, Texas, lie near the western periphery of the range of *S. olivaceus*, where mesquite dominates the vegetation and sizeable trees are scarce. Thus the lizards that occur there are confined to a life on substrates little to their liking as compared with those in central Texas; only 6.7 per cent of Blair's animals (Blair, 1960: 117) occurred on mesquite when elms and hackberry were available. The species is essentially arboreal, although "with terrestrial tendencies" (Carpenter, 1978: 34). *S. u. consobrinus* is largely terrestrial, with arboreal tendencies. The two species thus perforce interact much more frequently where the tallest vegetation tends largely to be shrubby, as in the study area. Unfortunately Maslin took no *S. olivaceus* where his *S. u. consobrinus* were collected. As rare as we found *S. olivaceus* to be nearby (see following), that is perhaps not surprising.

The possibility of interbreeding is also enhanced by similarities of display action patterns, inasmuch as the sharply different male semeions do not function in mate choice, but in intrasexual competition (Noble, 1934; Noble and Bradley, 1933). Carpenter (1978: 57, 58), summarizing an extensive survey of display action patterns (DAPs) throughout the genus *Sceloporus*, noted that the DAPs of *S. undulatus* are "similar to the *spinosus* group forms" and that "On the basis of the DAPs, a close relationship is suggested between the *formosus* group, *spinosus* group, *undulatus* group and *graciosus* group." That conclusion conforms with deductions on morphological grounds (Smith, 1939).

Present information suggests hybridization of males of larger species (*S. olivaceus*) with females of the smaller species (*S. u. consobrinus*), and not the reciprocal, because no convincing evidence is known to us of introgression of *S. u. consobrinus* character-states into the *S. olivaceus* genome. Fitzgerald (1982) has shown that size is an important factor in conspecific mate selection by males in a variety of iguanoid lizards, including four species of *Sceloporus* (*S. u. erythrocheilus* Maslin among them). The relative importance of male and female choice has never been determined for any member of the genus *Sceloporus*, however; since female choice occurs widely among vertebrates (O'Donald, 1977), it may be expected to occur also in *Sceloporus*. It is an important topic for future research.

Whether size is an important factor in interspecific mating preferences is also unknown in *Sceloporus*, but we suspect it may be. If it is, then for that reason hybridization is again more likely between male *S. olivaceus* and female *S. u. consobrinus*, given the interspecific disparity in size (male *S. olivaceus* larger than male *S. u. consobrinus*) (Fig. 7). Steel and Keenleyside (1971) have described an experimental design that might serve as a model for investigating the problem of interspecific discrimination between these two species.

The Variants in *S. olivaceus*

Under the mistaken initial impression that the aberrant female *S. u. consobrinus* previously described was a *S. olivaceus* or a distinct species, we searched southern Coke Co. within 10-15 km of Maslin's collecting site. We were not looking especially for *S. u. consobrinus*, and found but two typical hatchlings. We had assumed that what we sought would be arboreal. Of course we found none to match Maslin's odd female, but we did capture five *S. olivaceus*. One very large female was released. The others were typical in having 29-30 dorsal scales, 7-8 interfemoral scales, and 12(1), 13(5) or 14(2) femoral pores; the one female measured 80 mm s-v, the three males 79-82 mm. In size, number of dorsal scales and number of interfemoral scales they are, as expected, sharply distinguished from the smaller *S. u. consobrinus*, with its smaller dorsal scales and fewer interfemoral scales. The males, as usual, were conspicuously different in having no gular semeions and much reduced abdominal semeions. One male, however (56232), had a black medial border on its abdominal semeions (Fig. 8), a condition never before reported in *S. olivaceus*, in which normally a very narrow, pale blue semeion is present on each side of the abdomen, not black-bordered. Although a black border on the medial edge of the abdominal semeions is characteristic of most members of the *spinosus* and *undulatus* groups, it has been lost, as a derived condition, in *S. olivaceus*. Smith (1939: 113), having examined some 150 specimens, simply stated that the black border does not exist, and Blair (1960: 60-62) did not record existence of a black border on any of the thousand or more males he observed.

The odd male was probably no older than the other makes taken at the same time and place, since they are of nearly the same s-v length. Hence the presence of a black-bordered semeion is not likely age-related, despite Blair's (1960: 60) note that the pale blue semeion "increases in width and intensity of coloring with age." The blue area and its black border together are only four scales wide at most, hence it appears the the black border replaced part of the area that would normally be expected to be blue. Nevertheless, the two abdominal semeions are separated by a minimum of only four scales, whereas six is typical.

Quite unexpectedly, the same odd male has a narrow contact of the rear (5th) supraocular with the parietal on the right side, and a broad contact (about half of its entire posteromedial border) of the same scales on the left (Fig. 9). Smith (1939: 114), on the other hand, found a narrow contact only of but one supraocular on one side in three specimens out of 141 examined, and the other four *S. olivaceus* taken in the study area had uninterrupted oculofrontoparietals. The contact in 56232 on the left side is the largest ever recorded in the species; the other recorded contacts are narrow, as on its right side.

In our opinion, both aberrant features of 56232 are products of selection pressures that are substantially different at the periphery of the range of the species, as compared with those at the center of its range. We can conceive of no other explanation for them, consistent with all available information. One aberration (the interrupted oculofrontoparietals) is definitely atavistic, whereas the other (the black-bordered abdominal semeion) is either anticipatory (of the condition in *S. undulatus*, derived from a common ancestor with *S. olivaceus*), or atavistic - probably the latter.

Certainly there is ample evidence of unusual stress on *S. olivaceus* in the Coke/Tom Green counties area. Not only is that area at the periphery of the range of the species (Fig. 5), and the preferred large trees very scarce, but these counties are much drier than Travis county (where Blair's study took place); the latter gets about 34 in/yr of rain, Tom Green Co. about 20 (U.S. Dept. Agri., 1941: 1134). Blair (1960: 98, 175) found that a severe drought in 1954 and 1956 (with 11.4 and 15.4 in/yr respectively) reduced reproductive potential greatly - to less than half of the maximum occurring in other years with plentiful rainfall (27.7-29.7 in/yr; Blair, 1960: 18).

Thus it seems likely that suboptimal vegetation and moisture are the primary sources of stress for *S. olivaceus* in Tom Green and Coke counties. Temperature differences between those counties and Travis county appear not to be of sufficient magnitude to have any effect upon the success of the lizards.

Whatever the reasons may be, certainly *S. olivaceus* is far less common where we worked than at Blair's site; in about 15 man-hours of intensive searching we saw only six adults and two juveniles.

The species is most abundant, as might be expected, more or less in the central part of its range, where it is best adapted to the combination of environmental factors occurring there. Blair (op. cit.: 72) recorded about 20/acre of breeding adults on a tract near Austin, Texas, and observed that they were equally abundant elsewhere in that general vicinity. Over a five-year period he marked more than 3000 individuals on a 10-acre tract (op. cit.:4); approximately 80 per cent of the hatchlings survived to maturity (op. cit.: 173, 175). There was a potential production of over 4000 individuals per yr (op. cit.: 98). Thus this highly arboreal and heliophilous species is very abundant where environmental conditions are favorable, as in the central part of its range. Conditions are progressively less favorable toward the peripheries of its range, however, and accordingly population densities drop dramatically; selection pressures are not only more severe, but change also in character from those to which the species is best adapted. As stated by Mayr (1963: 393), "Central populations, being in the area ecologically most favorable for the species, tend to build up large populations the size of which is mainly controlled by density-dependent factors...Low density populations from near the tolerance limits of the species are being selected for adaptation to density-independent factors."

Commonly the different peripheral selection pressures in any species result in lower variability than occurs centrally, although species differ in their reaction; in some species variability is not diminished peripherally (Mayr, 1963: 389-393).

It is our observation, based on examination of some peripheral populations of *S. olivaceus* that variability is, in this case, even greater in peripheral than in central populations. Indeed, augmented peripheral variability would seem to be at least one route to the evolution of taxonomically distinct peripheral isolates (Mayr, 1963: 496).

In this context it may be significant that the specimens mentioned by Smith (1939: 114) with a narrow contact of one supraocular with the median head scales are also from a peripheral locality (Tamaulipeca, Tamaulipas).

Acknowledgments

We are much indebted to Mr. Craig Demere, owner of the ranch 3 mi N Water Valley, Texas, for permission to collect on his land; to Mr. and Mrs. Kenneth Fincher, owners of the ranch 5 mi N Water Valley, for help in finding a suitable collecting site; and to Adam Chiszar for help in the field. The photographs were taken by Larry Harwood, staff photographer at the University of Colorado. Dr. Shi-Kuei Wu kindly curated the material studied.

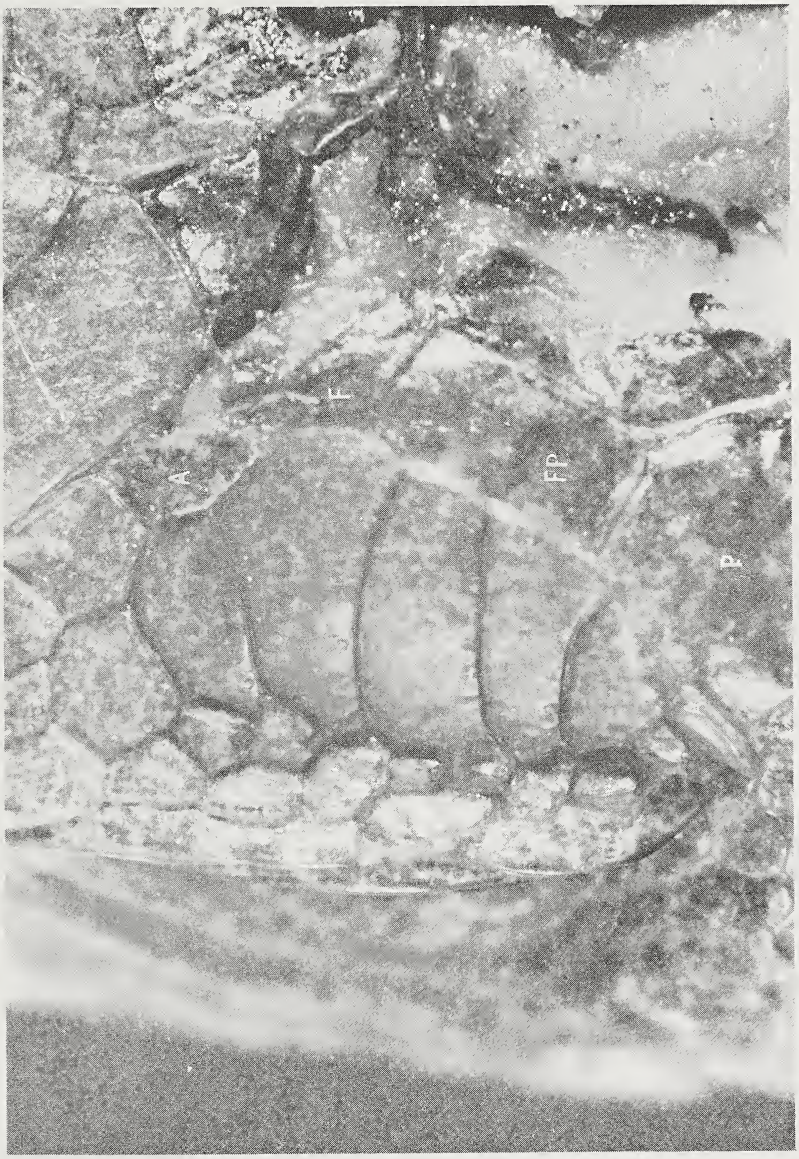

Fig. 1. *Sceloporus undulatus consobrinus*, CUM 7940, 32.2 km NW San Angelo, Tom Green Co., Texas. Dorsal view of left orbital area, showing the lengthy interruption of the oculofrontoparietal series. A, A, oculofrontoparietal scales bordering the interruption; F, posterior section of frontal; FP, frontoparietal; P, parietal.

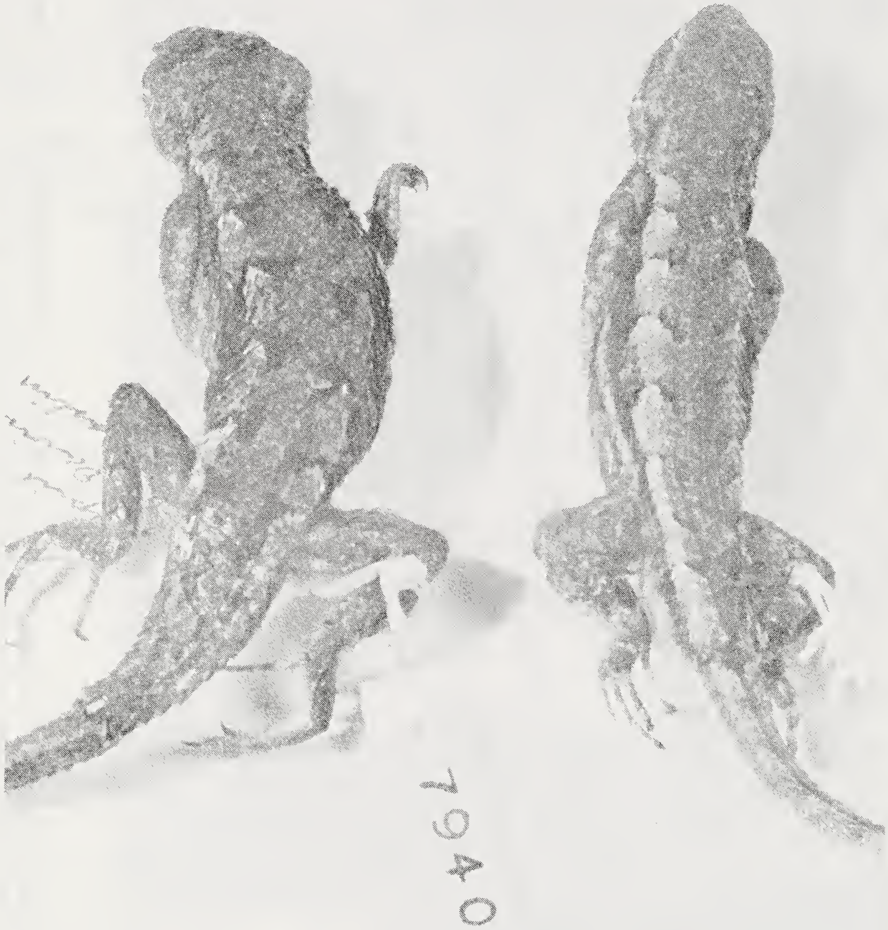

Fig. 2. Dorsal view of *Sceloporus undulatus consobrinus*, 32.2 km NW San Angelo, Tom Green Co., Texas. Left, female, CUM 7940; right, male, CUM 7939. The pattern is aberrant, presumably of hybrid origin with *S. olivaceus*. S-v length of female 60 mm, male 52 mm.

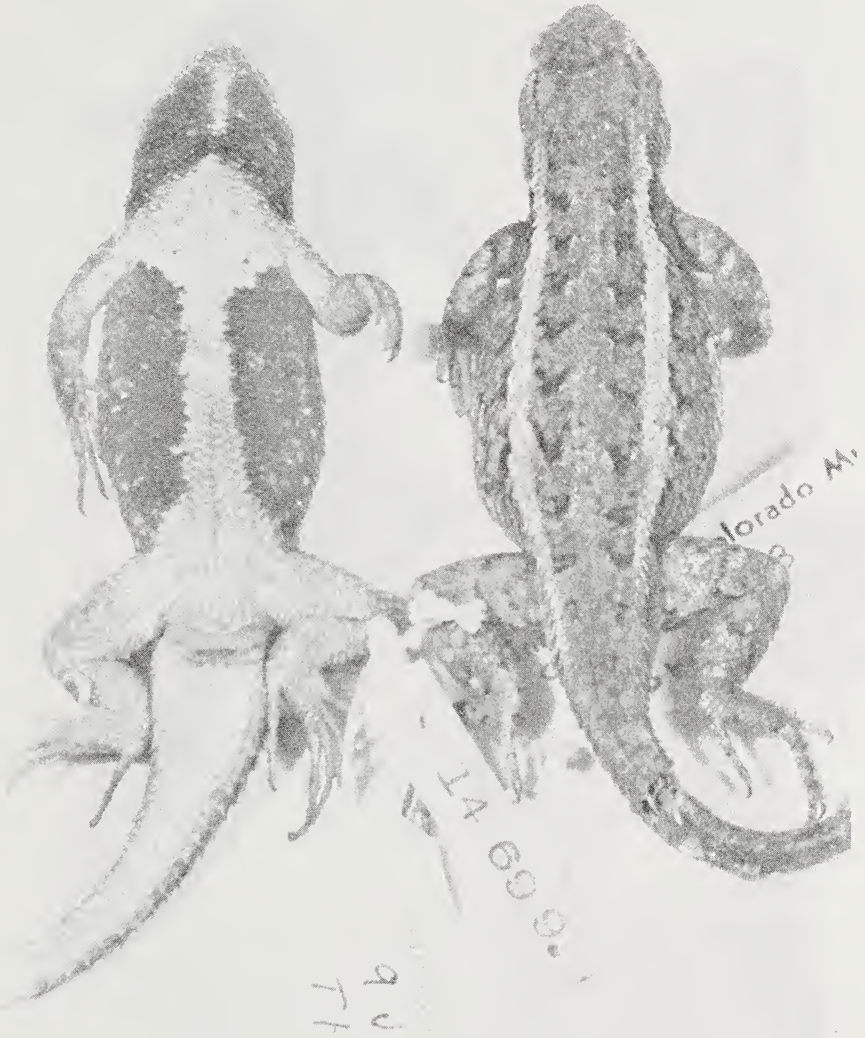

Fig. 3. Dorsal and ventral views of *Sceloporus undulatus consobrinus*, showing the typical dorsal pattern with uninterrupted dorsolateral light lines, and the extensive semeions of males. Dorsal view, CUM 13572, female, 57 mm s-v, 13 mi E Canyon, Randall Co., Texas. Ventral view, CUM 14699, male, 55 mm s-v, 20 mi E Van Horn, Culberson Co., Texas.

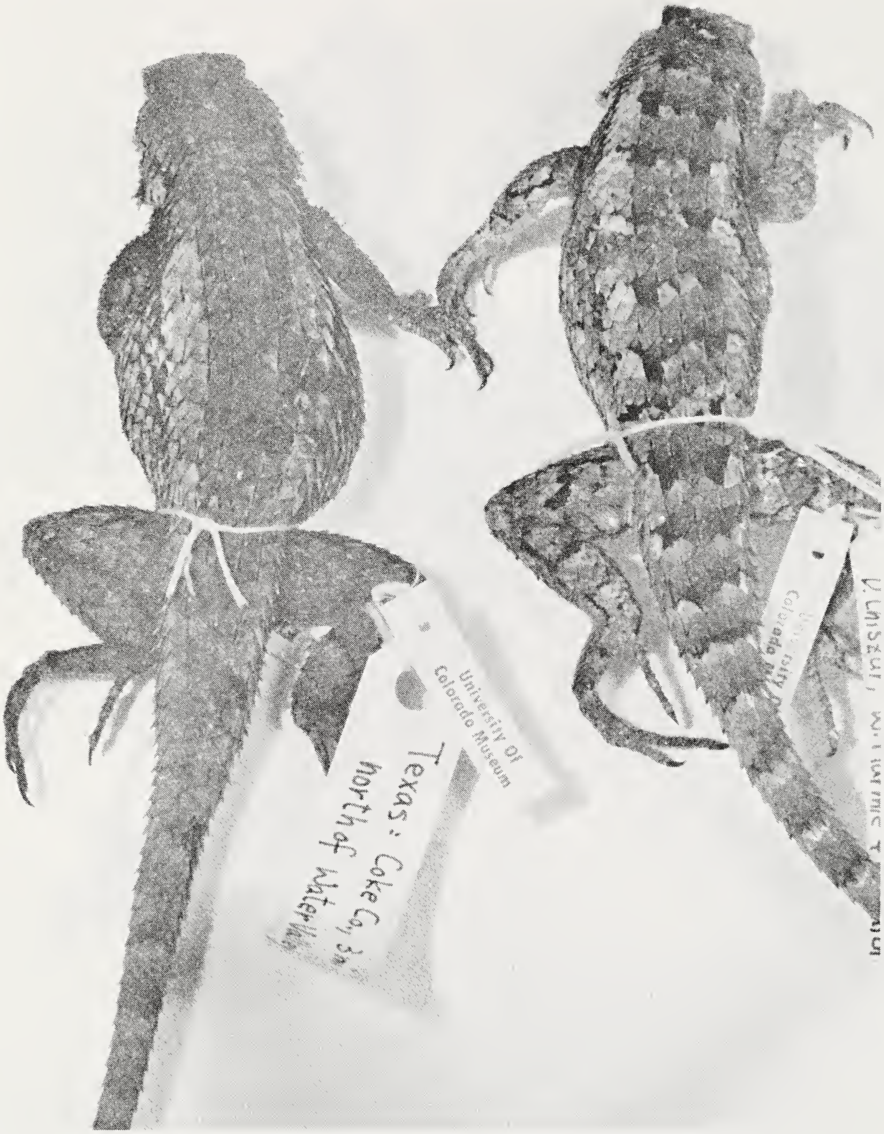

Fig. 4. *Sceloporus olivaceus*, 4.8 km N Water Valley, Tom Green Co., in Coke Co., Texas. Right, CUM 56230, female, s-v 80 mm. Note the similarity to the pattern of *S. u. consobrinus* hybrids, in Fig. 2. Left, CUM 56232, s-v 81 mm. Note the virtually complete loss of the transverse dark bars, and greater conspicuousness of the dorsolateral light lines.

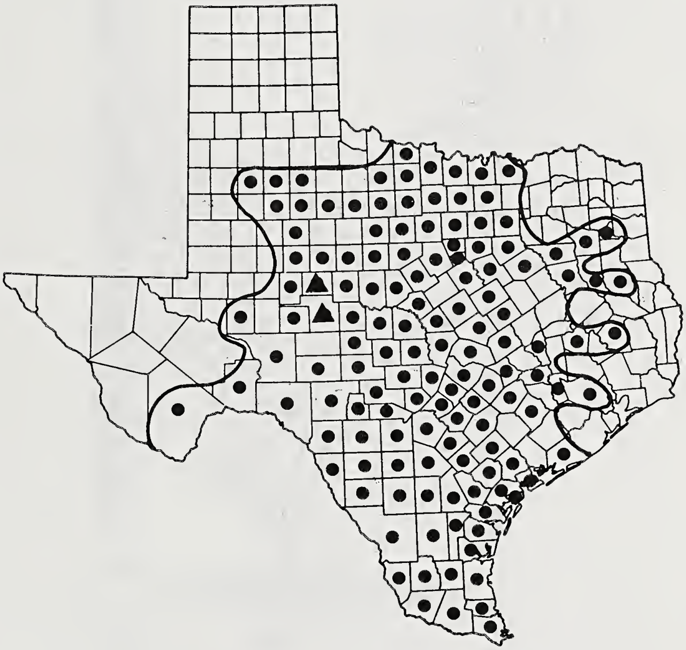

Fig. 5. County range of *Sceloporus olivaceus* in Texas, modified from Dixon (1987: 213). The triangular dots denote Coke (north) and Tom Green (south) counties.

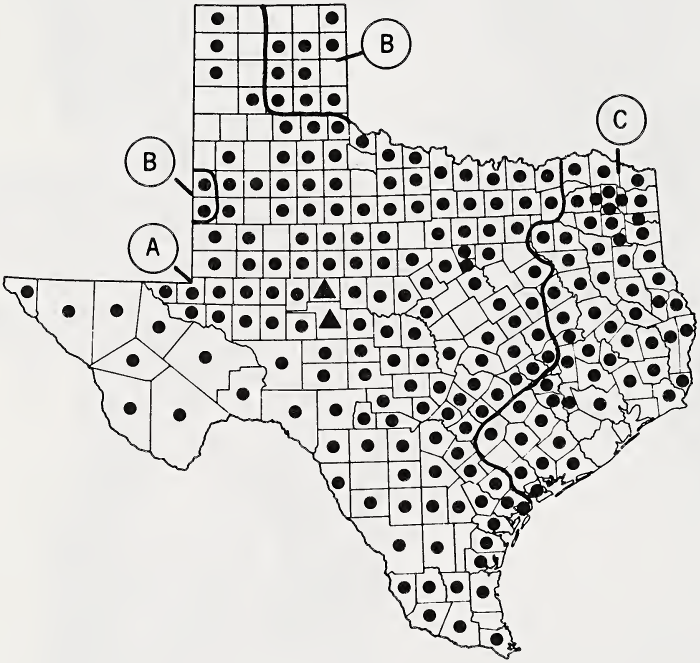

Fig. 6. County range of *Sceloporus undulatus* in Texas, modified from Dixon (1987: 215). The triangular dots denote Coke (north) and Tom Green (south) counties.

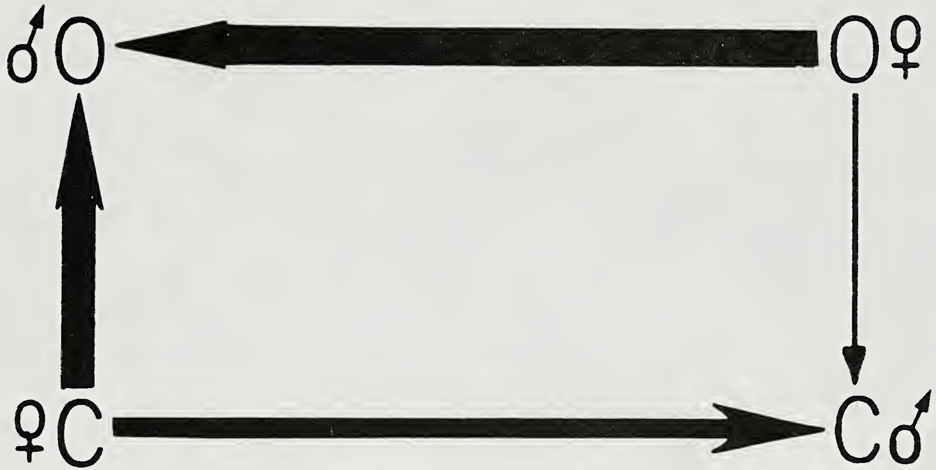

Fig. 7. Postulated hybridization potential in S. *olivaceus* (O) and S. *u. consobrinus* (C). Width of vector lines is roughly proportional to hypothesized preference, based on size.

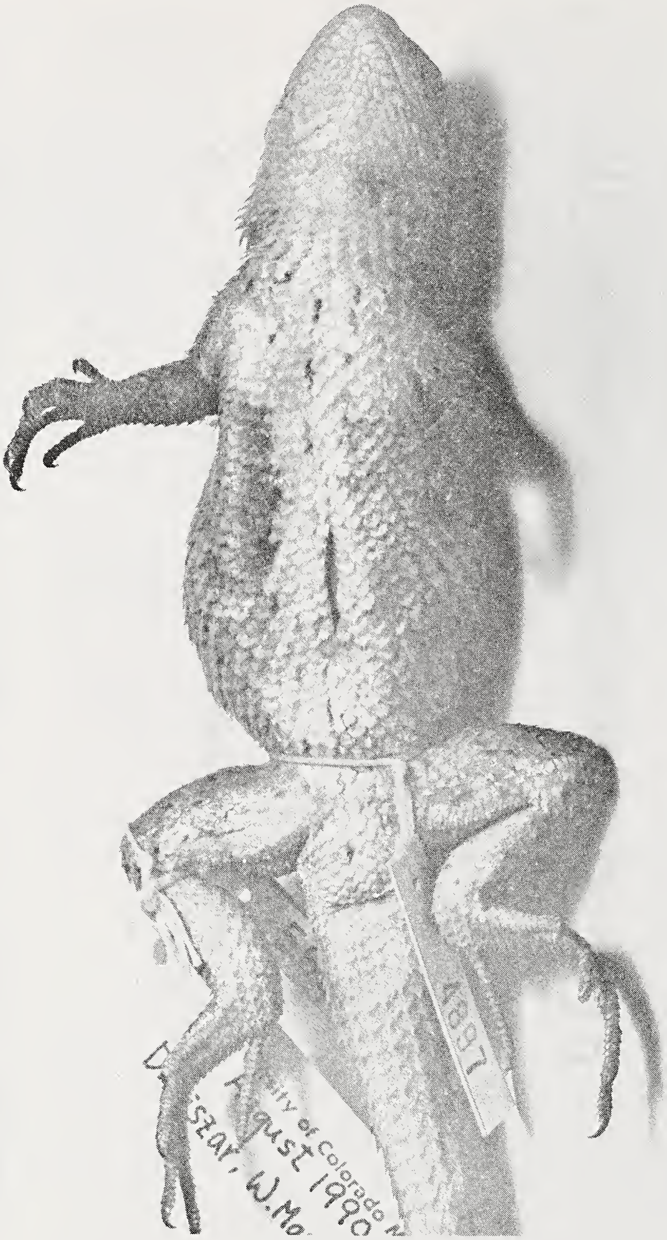

Fig. 8. *Sceloporus olivaceus*, CUM 56232, 4.8 km N Water Valley, Tom Green Co., in Coke Co., Texas. Ventral view showing the black borders of the lateral abdominal semeions, and their close approximation to each other. S-v 81 mm.

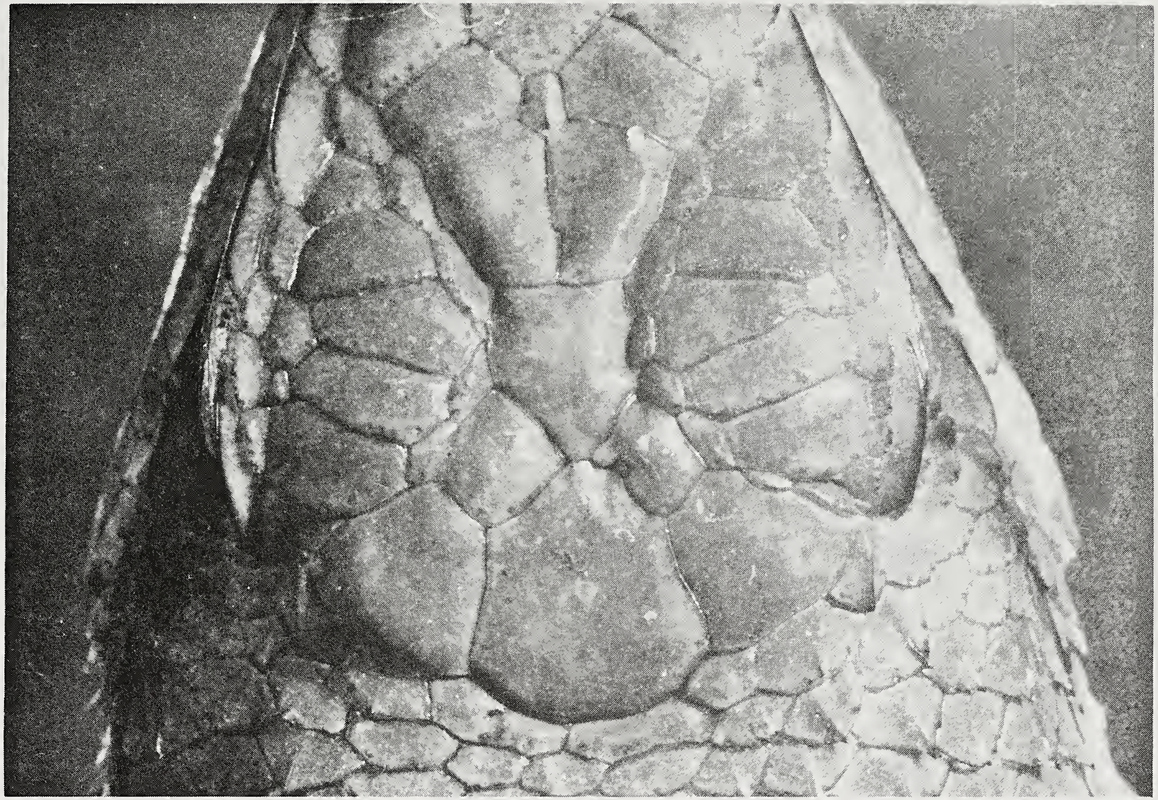

Fig. 9. Dorsal view of supraocular region of S. *olivaceus*. CUM 56232, 4.8 km N Water Valley, Tom Green Co., in Coke Co., Texas. Note the narrow contact of the posterior supraocular with the parietal on the right side, a half-length contact on the left. These contacts are the maximum known in the species.

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THE STATUS OF THE THAI PALM VIPER, *TRIMERESURUS WIROTI*

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Abstract

A holotype in the Senckenberg Museum is designated for *Trimeresurus wiroti* Trutnau, and four specimens in the Museum referred to the same taxon are redescribed. A translation is also given of a prepublication account by Wirot Nutphand, and of Trutnau's original description. We conclude that this nominal species is not distinguishable at present from *T. puniceus*, whose range is thus extended northward some 360 km, and of which one specimen is described in detail. Should future work revive *T. wiroti* at either specific or subspecific rank, details presented here will help in fixing the name taxonomically. Comparisons are made with the American hognosed vipers of the genus *Porthidium*.

An in-house paper bearing the date Sept. 24, 1980, was presented by Wirot Nutphand to a wildlife seminar in Bangkok, Thailand. It contained a description in Thai of a new species of *Trimeresurus* there called *T. wiroti* Klemmer. Nutphand had arranged to send material of that taxon to Klemmer for formal description, inasmuch as the seminar paper did not comply with the requirements for acceptable publication in zoological nomenclature under Art. 8 of the International Code, as Nutphand was well aware.

Unfortunately, Klemmer never published on the material, which languished unstudied in the Senckenberg Museum. However, one of us (LT) was well aware of Nutphand's discovery, having helped in transmitting the material to the Senckenberg Museum that Klemmer was supposed to use in formal announcement of the taxon. Assuming that Klemmer's description would appear promptly, LT described the taxon (in German) in his work on ophidian husbandry (1981: 138, 139, 188), where Code requirements for availability of the name *Trimeresurus wiroti* were met. Thus authorship of that name rests actually with Trutnau, not with Klemmer as originally intended.

The taxon nevertheless, in spite of its perfectly acceptable announcement, has remained little noticed, certainly in part from the fact that its original description (in Trutnau, 1981) was not noted in the zoological record, the mainstay of herpetological (and other) taxonomic (and other) currency. Thus Welch (1989) did not catch the name, nor has it been included in much of the scientific literature, although Hoogmoed (1986), in his review of Trutnau's book, observed that the original description of *T. wiroti* appeared there. Mehrtens (1987: 373) described, figured and supplied notes on the taxon from specimens in the Abilene Zoological Gardens.

We here provide translations of the Thai and German descriptions, and add notes on specimens in the Senckenberg and University of Colorado museums.

The Original Announcement

The following is a translation of the seminar paper, written in Thai, presented by Wirot Nutphand Sept. 24, 1980.

"Thai Palm Viper, New Species of Thai *TRIMERESURUS*,

Trimeresurus wiroti Klemmer

"*Locality*. In June 1979 we conducted field research to study the natural history of *Ophiophagus hannah*. Starting from Amphoe Thung Song, we followed Route 41 (in the north of Thung Song) and took our first rest at Ban Na Luang Sen, seven km from Thung Song, then followed Khlong Wang Hip and took a second rest there (Map of Thailand 1:50,000, series L 7017, sheet 4925 IV 1778 sheet Amphoe Chawang), on the border between Amphoe Thung Song and Amphoe Chawang, Nakhon Si Thammarat Province, southern Thailand. Its elevation is 1196 meters above sea level.

"*Habitat*. In June 1979, at Khao Wang Tip, we found five pit vipers of this species. The area is a dense forest (over 75% canopy) and always very humid. The area is covered with palms, such as Tao Rang (fish-tailed Palm), *Caryota mitis*; Hwai (Rattan), *Calamus* sp.; Saku (Sago Palm), *Metroxylon* sp.; and Kaw, *Livistoma* sp. Therefore, we called this snake the "Thai Palm Viper". The first specimen was found at 2000 hours crawling on a branch of rattan, 90 cm above the surface of the ground and about 20 meters from Khlong Wang Hip. Another specimen was found around Khlong Chede, Amphoe Lan Saka, six km east of Khao Wang Hip, 500 meters above sea level.

"*Diagnosis.* This is the smallest of the *Trimeresurus* of Thailand. The following is from specimen No. T 116, Siam Farm. Body length 468 mm, head 27 mm, width of head 17 mm, tail 90 mm, total length 558 millimeters. The head scales are small with spiny keels at the tip of the scales. The supraoculars are broken up into small scales, the rostral is vertically high and does not show on the top of the head. The anterior nasal is large and curved upward, which makes the snout curve upward, too. The fourth upper labial is large and does not contact the eye.

"The species is not common. I found it feeding in its natural habitat. It spends most of the time resting among small rocks. It hunts and eats geckos and frogs on the ground or in small bushes. This species is not aggressive.

"*Description.* The rostral is higher than it is wide and curves up at the nose. The supraoculars are broken and there are eight scales between them. The small scales on the head are not keeled except those on the occiput, the tip of each scale having an upward curving spiny keel. The preoculars are divided into three small scales and there are 11 upper labials, the first contacts the rostral, the fourth is large and not in contact with the eye. There are three snall postoculars and the large eyes have vertical upuils. The large mental is wider than the rostral. Of the 11 lower labials, two touch the first pair of chinshields. This snake has the special distinction of having shaped keels from the fourth uppler labial up to the back of the postocular in the area below the eye to the pit, from the upper precular to the nasal.

"The dorsal body scales are keeled. The formula for the scale rows is: occiput 28, neck 17, middle 21, before vent 14. The anal is single. There are 176 ventrals and 109 paired subcaudals.

"*Color.* The body is dirty green-brown, the ventral surface light brown with white spots between the dorsal scales and ventrals, and the subcaudals dark brown. The top of the head is dark brown with a pattern of dirty green. There are white spots on the supraoculars and labials, the chin is Indian red, and the body is banded with dark brown and dirty green, Indian red, or pink lines to the insertion of the dorsal scales to the ventrals. The end of the tail is brown or light brown. The eyes are dark green with vertical pupils; the interstitial skin is pale violet.

"*Remarks.* In January 1980, these specimens were sent to Mr. Reimann and Mr. Ludwig Trutnau, then to Dr. Konrad Klemmer, Senckenberg Museum, Frankfurt, West Germany, who received these specimens for examination.

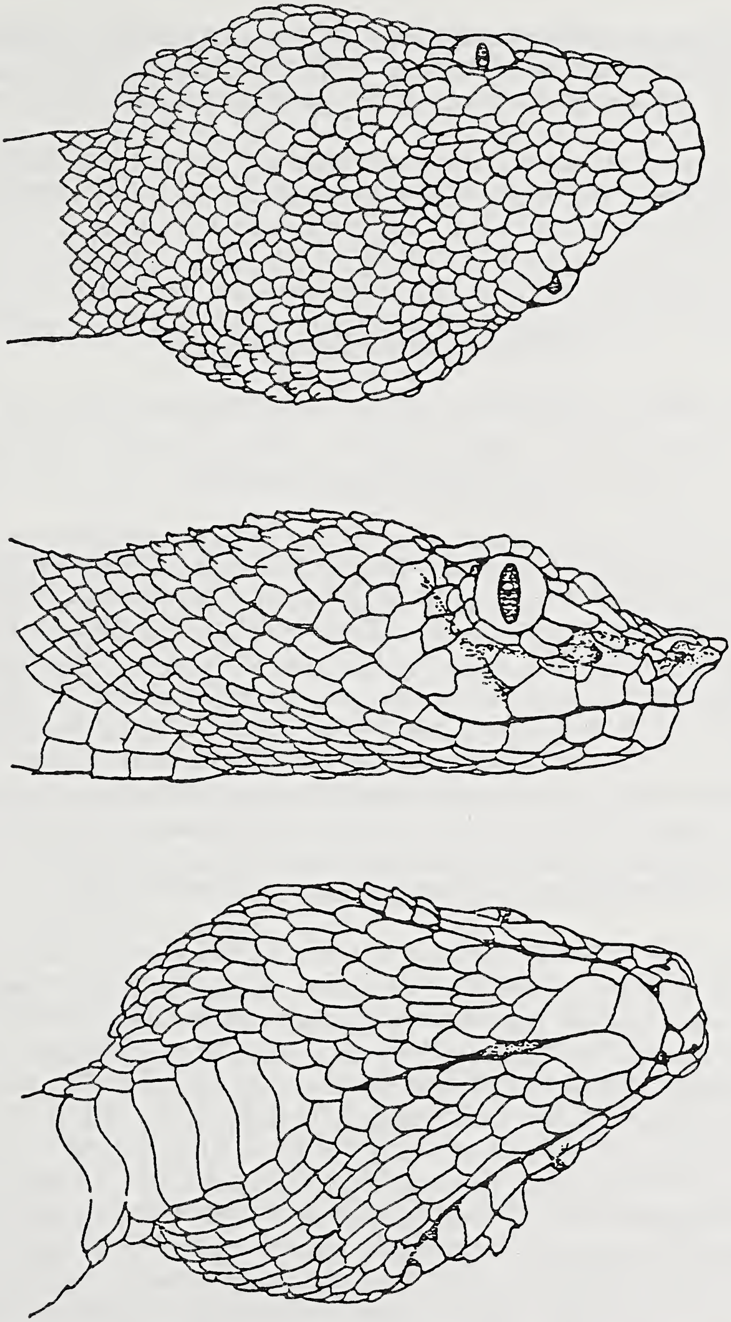

Fig. 1. Head scales in dorsal, lateral and ventral aspects of a specimen assigned originally to *T. wiroti* (now *T. puniceus*) as depicted in a seminar report by Nutphand in 1980. Locality as given in the text.

"The species of the genus *Trimeresurus* in Thailand, therefore, are: *albolabris*, *popeorum*, *stejnegeri*, *erythrurus*, *purpureomaculatus*, *kanburiensis*, *puniceus*, *sumatranus*, *wagleri*, *monticola* and *wiroti*."

The preceding account was accompanied by three excellent drawings (Fig. 1) from the specimen figured on the cover pages of Nutphand's seminar report.

The Formal Original Description

The earliest description of *T. wiroti*, acceptable under the Code of Zoological Nomenclature, appeared on p. 188 of Trutnau's 1981 work; a figure (in color) appeared also on p. 139, its legend p. 138. A translation of the German text, p. 188, follows.

"In June 1979 Dr. Wirot Nutphand and some of his friends found a new *Trimeresurus* species on a trip to study the natural history of the king cobra (*Ophiophagus hannah*), 100-150 km south of Surat Thani (southern Thailand), on the slopes of Khao Luang, between Amphoe Thung Son and Amphoe Chawang (in the Province of Nakhon Si Thammarat). The precise point of discovery of this smallest pit viper of Thailand lies on the Khao Wang Hip [range] at an altitude of between 500 and 1196 m near villages of 10-12 bamboo huts bearing the names of Ban Hui Hip and Amphoe Lan Saka. One of the 5 examples of this species, which should be described by Dr. K. Klemmer as *Trimeresurus wiroti*, I brought with me to Germany. I turned that animal over to the Senckenberg Museum (Frankfurt/Main).

"The habit of *Trimeresurus wiroti* is virgin rainforest. In that marshy, humid region is a canopy of palm trees such as *Caryota mitis*, *Metroxylon* sp., *Calamus* sp. and *Livistoma* sp. Since all the snakes were found in the evening or at night on palm fronds or in their axils, the German common name of "Siamese Palm Lance-headed Snake" is properly derived. This species reaches a length of 55.8 cm. Its body form is slender. The broad, lance-shaped head is distinctly set off from the neck. One species character of *Trimeresurus wiroti* is the distinctly turned-up tip of snout, by which this pit viper is distinguished at first glance from all other species of Thailand *Trimeresurus*. The upper surface of the head is covered with small scales, which have a fine keel at their tip. The supraoculars are likewise reduced to small scales. The rostral is produced vertically. The anterior nasal is large and likewise produced. The fourth supralabial is large. It does not contact the eye. Scale rows keeled, 17 on neck, 21 at midbody. Ventrals 176, caudals 109, divided. Body a dirty gray-green color with numerous brown flecks, which on middorsum are enlarged [as spots] spaced about equidistant apart. The scales in the supraocular area and the supralabials are white-flecked, as are those on sides of body. The chinshields are reddish. The venter is brownish. The dark green eye in light has a vertical pupil.

"The Siamese Palm Lance-headed snake is not common in its native habitat. Its diet consists of geckos and frogs, perhaps also small mice and birds. It is not aggressive. I saw it strike like lighting a long distance. *Trimeresurus wiroti* has at present been kept in captivity only a short time. It needs a warm, humid, profusely planted rainforest terrarium for its well-being, and tolerates there other species of *Trimeresurus*. See p. 139 for a figure."

Supplementary Notes

The description appearing in Trutnau's book (1981) was based on a single specimen, now 69695 in the Senckenberg Museum, Frankfurt a. M., Germany, transmitted from Nutphand by Trutnau. It is therefore the holotype, by virtue of its sole basis for the description. Although Trutnau saw four other specimens of the taxon at Siam Farm (an animal dealership), they formed no part of the actual description and should not, therefore, be regarded as syntypes. Those snakes are no longer extant.

The type locality for the holotype should read: Ban Hui Hip near Khlong Wang Hip, Amphoe Chawang, Changwat Nakhon Si Thammarat (Hui Hip village near Wang Hip canal, Chawang county, Nakhon Si Thammarat province), approximately 8°30' N, 99°30' E. The holotype was taken June 20, 1979, by Wirot Nutphand, donor.

Data taken by one of us (LT) on the holotype are: female; supralabials 9; infralabials 8; 10 scales between right and left supraoculars; 3 preoculars; snout upturned slightly; nasal contacting supralabials 1 and 2; dorsal scale rows 17-21-13; 177 ventrals; subcaudals 51, divided; tail-tip an obtuse spine, anal entire; total length 285 mm; tail 45 mm; dorsal scales strongly keeled, weakly on sides.

In addition, the Senckenberg Museum has three other specimens referred to *T. wiroti*: 69817, a male topotype, same collector, data and donor, given to Michael Reimann Jan. 15, 1980, for transmittal to the museum; and 74144-5, both females, taken by P. Hoch in "southern Thailand," Jan. 18, 1984. These three have the same features described for the holotype except, respectively: supralabials 9, 10, 9; infralabials 11,12, 9; scales between supraoculars 10, 12, 10; dorsal scale rows 19-21-13, 21-21-13, 20-21-14; ventrals 169, 165, 180; subcaudals 53, 45, 56; total length 425 mm, 418 mm, 537 mm; tail 71 mm, 56 mm, 75 mm.

A specimen in the Thai National Reference Collection (TNRC 52-3793) has 11-12 palatopterygoid and 11-12 mandibular teeth.

Additional variational data are provided in Cox (1991: 387-390), plus information on habitat, habits, food, temperament, etc.

According to Slavens (1989: 79, 447), as of Jan. 1, 1989, the Abilene (Texas) Zoo had 3 females, 3 males, and 7 juveniles; the Fort Worth Zoo 1 female, and the Steinhart Aquarium 2 of undetermined sex. The seven juveniles were "born" (presumably a lapsus for "hatched") at the Abilene Zoo during 1988.

The University of Colorado Museum possesses two specimens, one (56270), originally referred to *T. wiroti* (approx. 296 mm tl), the other to *T. puniceus* (female, 670 mm tl). The former is severely dehydrated, shrunken and stiff, but the snout form and other features of the cranial scutellation agree with those of the other specimen.

Comparisons with the literature convinced us that *T. wiroti* is not distinguishable from *T. puniceus*, the only "hognosed" species of the genus. None of the distinctions cited by Cox (1991: 389) suffice (because of extensive variational overlap) or are real (greater variation than then known). For example, CUM 56270, supposedly typical *T. wiroti*, has two scale rows between subocular and labials rather than one as thought to be diagnostic of *T. wiroti*; the temporal scales in CUM 56269, clearly a *T. puniceus*, has weakly keeled temporals, as in "*T. wiroti*"; and the supraoculars are highly variable in *T. puniceus*, not always modified as erect scales, but always subdivided to various degrees, as in "*T. wiroti*". The latter is supposedly smaller than *T. puniceus*, 558 mm vs 640 mm, but since specimens previously assigned to *T. wiroti* were found only 300-360 km north of the previously known range limit of *T. puniceus*, in extreme southern Thailand, they could at present be considered at most a peripheral variant of the latter species. With larger series even that apparent size difference may not prove to be real, for even now it is a matter of only 82 mm, and there is no important ecological difference between the two areas in Thailand. *T. puniceus* has a very wide range, given by Klemmer (1963: 435) as "Siam, Malaya, Mentawai Islands, Sumatra, Simalur, Natuna Islands, Borneo, Java."

Taylor (1965) was not aware of the existence of *T. puniceus* in Thailand, although he knew of its occurrence in more southern parts of the Malay Peninsula. He did note that Malcolm Smith's reference to *T. puniceus* at "Kanburi", Thailand (1930: 90) was a misidentification that he later corrected (1943: 519) to his new species *T. kanburiensis* from Kanchanaburi, Thailand. It is not a hognosed viper.

The presence of *T. puniceus* in Narathiwat Province, bordering Malaysia, has since been confirmed by two of us (WN, MJC). To date, specimens have been found in the southern Thai provinces of Surat Thani, Nakhon Si Thammarat, Krabi, and Trang. The northernmost of these provinces, Surat Thani, is approximately 500 kilometers north of Narathiwat province, the previous northernmost known range limit of *T. puniceus* in Thailand. It is likely that the range of *T. puniceus* reaches its northernmost extent in Thailand.

Since a detailed description of *T. puniceus* does not exist, calling attention to the very strange modifications of the scales on the snout, the following description of CUM 56269 is provided.

Female, total length 670 mm, tail 85 mm; ventrals 163, subcaudals 44; anal entire; scale rows 21-21-15. Vertical orbit diameter three-fifths distance from lip. Snout broad as seen in dorsal view, only slightly bowed anteriorly, protuberant dorsally and slanted anteriorly as seen in lateral view, its bilobed tip raised 0.5 mm, center flat; lobes of snout projection formed by enormous nasals, apparently entire, and large, upturned anterior supranasals pressed against upper anterior edge of nasals; nasal reaching top of snout ridge on one side, one of a pair of anterior internasals intervening on the other. Nasal reaching lip between the small rostral, that does not reach dorsal surface of snout tip, and first supralabial; second supralabial very large, reaching deep into anterior border of fovea; third supralabial still larger, its labial border more than twice as long as that of any other supralabial, separated from subocular by one scale; one elongate infrafoveal, broadly contacting third supralabial, one elongate suprafoveal broadly contacting a large preocular, all three latter scales entering orbit; two canthals, anterior below posterior supranasal but on canthal ridge; a tiny loreal bounded by 1st and 2nd supralabials, anterior canthal and nasal; two rows of scales between subocular and supralabials (except the 3rd); no small scales around fovea; subocular elongate, single, rear end partially separated as a small postocular; 3-4 postoculars; supralabials 11-11. Scales on top of head and in temporal region all small; supraocular region with small scales, largest about 2-3 times size of adjacent scales, flat, bordering anterodorsal edge of orbit; supranasals 2-2, nearly as large as largest supraocular; all scales on top of head smooth except lateral temporals; latter weakly and obtusely keeled; 10 scales (least count) between largest supraoculars. Infralabials 12-14, 1-1 contacting anterior chinshields, 0-1 contacting posterior chinshields; latter 2.5 times as large as former. Scales in lateral 3 or 4 dorsal rows smooth, others obtusely and weakly keeled near their posterior tips; no apical pits; most dorsal scales weakly striated. Tail more or less constant in diameter for about one third of its posterior length, indicative of prehensility.

General ground color tan or light brown, with 21 dark brown, subsquare vertebral blotches on body, spaced about their own length apart, three on base and middle of tail; terminal third of tail lightly pigmented, without dark blotches, presumably reddish in life. A color photograph of the species appears in a 1991 issue of the Reptile and Amphibian Magazine.

It is of interest that the American tropics also has at least seven closely related species of hognosed vipers in the genus *Porthidium* (*dunni, hespere, hyoprorum, lansbergi, nasutum, ophryomegas, yucatanicum*), widely distributed from central western Mexico to Peru and northwestern Brazil-a total range comparable in extent to that of *T. puniceus* (Campbell and Lamar, 1989; Klemmer, 1963). The two groups are similar in body size, color, pattern and shape of snout - a convergence of surprising complexity. There are numerous fundamental differences, however, documenting their completely independent origin. *T. puniceus* is oviparous, arboreal (with a prehensile tail), has the middorsal blotches entire, a triangular rostral, an enormous nasal forming part of terminal snout ridge, fovea bordered by three large scales, subcaudals divided, scales smooth or weakly, apically and obtusely keeled, and is limited to rainforests. The American hognosed vipers, on the contrary, are viviparous, terrestrial (tail not prehensile), have the middorsal blotches divided by a narrow, light vertebral line, the two halves often staggered, a rostral higher than wide and with parallel sides for much of its length, a smaller nasal not forming part of the terminal snout ridge, fovea bordered in part by several small scales, subcaudals entire, scales on body mostly with long, strong, acute keels, and they occur in both semiarid and rainforest habitats.

It may well be that *T. puniceus* as at present understood may actually consist of more than one species, or be polytypic, but present evidence does not so indicate. Much more material is needed to permit definitive conclusions.

Acknowledgments

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THE ORIGINAL DESCRIPTION, TYPE SPECIMEN AND STATUS OF THE COLUBRID SNAKE *BOIGA SAENGSOMI* NUTPHAND

Wirot Nutphand, Merel J. Cox, Hobart M. Smith and David Chiszar

Abstract

A translation is given of the original description of *Boiga saengsomi* Nutphand, 1985, with supplementary notes on the lectotype and two other specimens, and comparisons with other Thailand species of the genus.

The species of *Boiga saengsomi* Nutphand (1985) was originally described in the Thai language in a little-known, separately issued, six-page pamphlet from the Thai Zoological Center of Bangkok, Thailand. As a result, it received scant notice in herpetological literature, although one of us (Cox, 1991) includes an account of it in a review of the snakes of Thailand. The species appears to be valid, but was not noted by Welch (1988) or Greene (1989).

Since familiarity with the Thai language is very limited among herpetologists, a translation into English from the original description follows.

"Banded Green Cat Snake

"*Boiga saengsomi* Nutphand (new sp.)

"December, 1985

"This species has the outstanding characteristics of the genus *Boiga* found in Thailand. For instance, the head is large and round, the eyes large, the neck slender, the body long and tapering, the tail tapered and pointed. The eyes are large and the pupils vertical. The parietals are very large, the preoculars single, there are two postoculars, eight supralabials, and 11 infralabials. The body scales are in rows of 19-21-16, the scales are smooth and the skin black. The vertebral scales are not large, being almost the same size as the body scales. The anal is single and the dorsal tail scales are larger than the body scales. The subcaudals are paired. The rear fangs appear to be clearly opisthoglyphic.

"*Habitat and Length.* Specimen number one, a male, was captured at midday while lying coiled on the branch of a tree four meters above the ground. It was found in a thick forest in Amphoe Sikao, Trang Province, 60 kilometers west of Amphoe Muang Trang, 170 meters above sea level. Length: head, 34 mm; body, 1210 mm; tail, 315 mm.

"Specimen number two, a female, was sent by Mr. Buntot Saengmahasom in a shipment from Amphoe Thung Song, Nakhon Si Thammarat province. The shipment, including *Boiga drapiezii*, *Lycodon fasciatus*, and *Lycodon laoensis*, was collected at Ban Kanom, Amphoe Khao Phanom, Krabi Province (Amphoe Khao Phanom is 50 kilometers northeast of Krabi city at an elevation of 150 meters above sea level). The specimen was caught during the day while coiled and sleeping on the roots of a tree near a river. Length: head, 39 mm; body, 1230 mm; tail, 349 mm.

"*Color.* The top of the head is olive. The labials are yellow with black sutures. The chin is yellow, the anterior chinshields white. The interstitial skin is black, the eyes are yellowish-green. The inside of the mouth is a dirty white color. The body scales are greenish-yellow and there are alternating, narrow yellow and yellowish-green bands on the back, each about two cm wide. The scales on the tail are black with large yellow spots in the center. The ventrals are yellowish-white with black edges.

"*Discussion.* The Banded Green Cat Snake has characteristics which obviously place it in the genus *Boiga*. Specimen number two is alive at this time (December 6, 1985) and is being kept at the Pata Zoo in Bangkok. It has characteristics and colors similar to the other *Boiga* of Thailand, especially *Boiga cyanea*, but is dissimilar from *Boiga cyanea* in the following ways: head rounder; rear fangs smaller; scales on tail larger; body longer and larger; color olive, not bluish green; black bands distinct; interior of mouth white. In addition, it coils the body much differently, is more irascible and does not flee as quickly. At present, only two specimens have been found in southern Thailand.

"Specimen number one died 60 days after arrival due to injuries during capture. It is now kept in the collection of the Thai Zoological Center."

Translator's Note. Two errors appear in the original description. The measurements of the two specimens are incorrect. They are presented correctly in the preceding translation. It was specimen number one, not specimen number two, that died 60 days after arrival. That also is here given correctly.

Remarks. The two specimens on which the preceding description was based are syntypes, since no holotype was designated. Specimen number two seemingly was the primary basis of the description, and is therefore here designated as lectotype, with a type locality of Ban Kanom, Amphoe Khao Phanom, Krabi Province, southern Thailand. It was kept alive and healthy in the collection of the Pata Zoo in Bangkok until it died Sept. 7, 1990. It is now TNRC 52-3795 in the Thai National Reference collection of the Thailand Institute of Scientific and Technological Research, 196 Phahonyothin Road, Bangkehn, Bangkok 10900, Thailand, and served as the model for the drawings reproduced here (fig. 1) from the original description. The specimen that "died 60 days after arrival" is a sole paralectotype.

The species was named, by contraction, for its collector, Mr. Buntot Saengmahasom. Supplementary data on the lectotype follow: rostral relatively small, somewhat triangular; paired nasals and internasals in contact medially, latter contacting single loreal; paired prefrontals contacting single preocular on each side, also supraocular and frontal; loreal contacting 2nd supralabial; each supraocular about width of frontal; postoculars 2-2; anterior and posterior temporals each 3-3; nuchals 12 (contacting parietals between right and left postoculars); supralabials 8-8, 3rd, 4th and 5th entering orbit; infralabials 12-13, 8th largest, 1st in contact with its mate behind mental; posterior chinshields separated by two small scales. Ventrals 238; subcaudals 116; anal divided. Dorsal scale row sequence on body: 29, 5 + 6(5)/6 +7(6) 27, 5 + 6(7)/5+6(8), 25, 4 + 5(11) 24, 11 + 12(12)/4 + 5(12) 22, 11 + 12 (21) 21, 12-11 & 12(59) 22, 12-11 &12(62) 23, 11+ 12 (109) 22, 11 + 12 (126) 21, 10 + 11 (147)/10 + 11(146) 19, 3 + 4(152)/3 + 4 (154) 17, 8 + 9 (161)/8 + 9(165) 15, 9-8 & 9(237) 16. Dorsal scale row sequence on tail: 14, 1 + 2(2)/2 + 3(2)/6 + 7(2) 11, 2 + 3(3) 10, 3 + 4 (4)/4 + 5(4) 8, 2 + 3(6)/ 2 + 3(6) 6, 2 + 3(35)/2 + 3 (42) 4. Maxillary teeth 11 + 2, fangs grooved, but only 1.2 times length of anterior teeth; mandibular teeth 18, palatine 7, pterygoid 16. Weight 872.5 grams August 26, 1990. Snout-vent length 1580 mm, tail 459 mm.

The dorsal pattern in life of the lectotype is depicted in Fig. 2, which is somewhat deceptive, not doing justice to the bright yellowish green color evident in an excellent color slide taken at the same time, with the snake in exactly the same position. The light transverse bars and dark, blotchlike areas between them are not apparent on the color slide except on the tail; the crossbars are simply a slightly lighter green color than the intervening areas, and the areas on the body appearing as dark blotches in the figure are mostly groups of black-edged scales, or scales separated by black interstitial skin.

The paralectotype differs from the lectotype in having 245 ventrals and 117 subcaudals; the infralabials are 12-12.

A specimen presented by the first two authors (WN, MJC) to the University of Colorado Museum (CUM 56267) is an adult female, 1676 mm tl, 378 mm t and has the same cephalic scutellation as the lectotype except for four secondary temporals on one side, 11 nuchals, five infralabials contacting anterior chinshields. Ventrals 231, subcaudals 121. Emaciated, perhaps discolored from formalin, very stiff. Entire dorsal surface dark, but not jet black; ventral surfaces light, increasingly suffused with gray, especially laterally, toward rear of body; light ventral color encroaching onto lower 3-4 dorsal scale rows as subtriangular marks spaced 3-4 ventrals apart, much reduced toward rear of body. Ventral surface of tail gray, with scattered, irregular black flecks. Sides and top of head black, with only a few light areas on the labial edges of the subocular supralabials.

The coloration and markings of the CU specimen are much darker and subdued in preservative than on the holotype in life. It is assumed that the differences are largely due to discoloration of the CU specimen.

As noted in the original description, *B. saengsomi* resembles *B. cyanea* (Duméril, Bibron and Duméril) to a certain degree. Both are green in life, at least as adults, and differ in that respect from all other species of the genus in Thailand. The two species differ markedly, however, in a number of features in addition to those mentioned in the original description.

The three specimens available to us of *B. saengsomi* have few subcaudals (116-121 vs 124-138) (a lapsus in Taylor, 1965: 874 gives the range as 144 to 158, presumably intending to quote the correct range given in Smith, 1943: 355), and one fewer maxillary teeth (11 + 2 vs 12 -14 +2). Taylor (1965: 873) notes the presence of 9 supralabials and 2 + 3 temporals in *B. cyanea*, whereas our *B. saengsomi* have 8 supralabials and 3 + 3 temporals.

However, Taylor and Elbel (1958: 1143) record one *B. cyanea* with 8-8 supralabials and 3 + 3 temporals, and one live *B. cyanea* in the laboratories of the Center for Ophidian Ethology at the University of Colorado (David Chiszar, Director) has 2-3 anterior temporals and 8-8 supralabials, hence those characters do not reliably distinguish the two species.

Nevertheless the two differ conspicuously in color, pattern and habitus. In *B. cyanea* the green color is very dark and uniform over body and tail, virtually no black edging is visible on the scales (although interstitial black is present), the ventral surfaces are completely devoid of black markings on both tail and body, the interspaces between the light crossbands (where visible, especially in the young) are only 1-2 scales long, and the body is very slender. On the contrary, in *B. saengsomi* the green color is yellowish, much lighter and of varied hues over body and tail, many dorsal scales are black-edged, the subcaudals are conspicuously black-flecked, the inter-spaces between the light crossbands (where visible) are 3-4 scales long, and the body is distinctly stouter. In addition, the largest enlarged vertebrals are twice as wide as long in *B. saengsomi*, about equally as wide as long in *B. cyanea*. The latter is probably the most reliable and useful scale character separating the two species. Color photographs of both species appear in a 1991 issue of the Reptile and Amphibian Magazine.

In captivity, the lectotype was cosmopolitan in acceptance of food, taking mice, chicks, ducklings, chicken eggs and snakes. A large guinea pig 33% of its weight was subdued by constriction and readily consumed; smaller prey were not constricted (see Chiszar, 1990). Venom did not appear to play a role in subduing prey consumed under observation. Small prey was swallowed alive, whereas large prey was killed by constriction before being swallowed. The species is probably euryphagous in nature; Greene (1989: 201) noted that *B. dendrophila* "is more euryphagic than other species in the genus." However, some others (e.g. *B. irregularis*) are highly eclectic in acceptance of prey animals (Fritts, 1988).

Acknowledgments

We are much indebted to Mike Goode of the Columbus, Ohio, Zoo and Peter Strimple of Cincinnati for aid in caring for comparative material, to Dr. Shi Kuei Wu for curating and permitting study of specimens in the University of Colorado Museum, and to Dr. Wolfgang Wüster for aid in recording data.

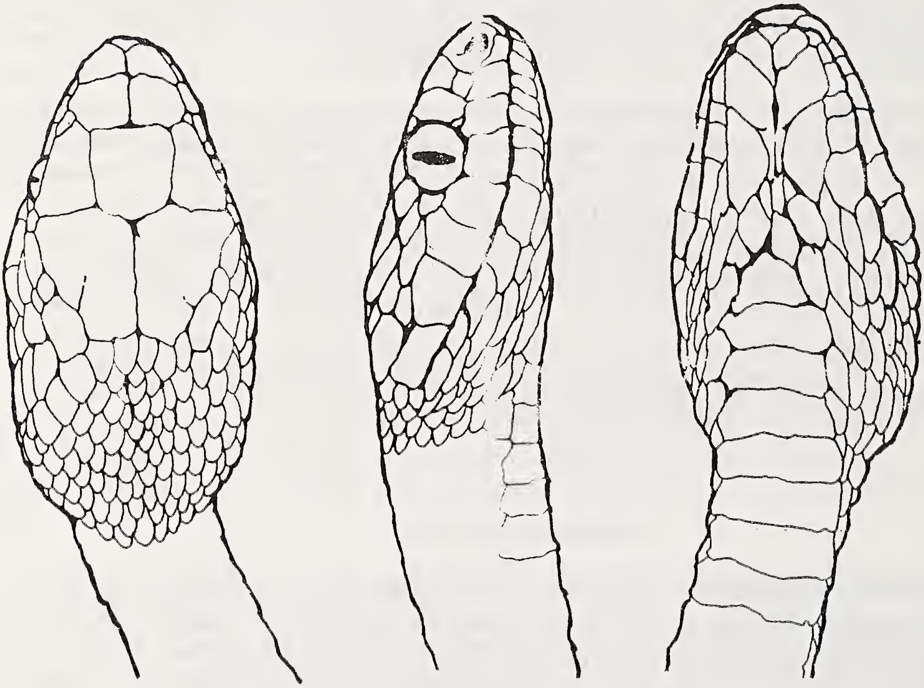

Fig. 1. Dorsal, lateral and ventral views of the head of the lectotype of *Boiga saengsomi*, reproduced from the original description (Nutphand, 1985).

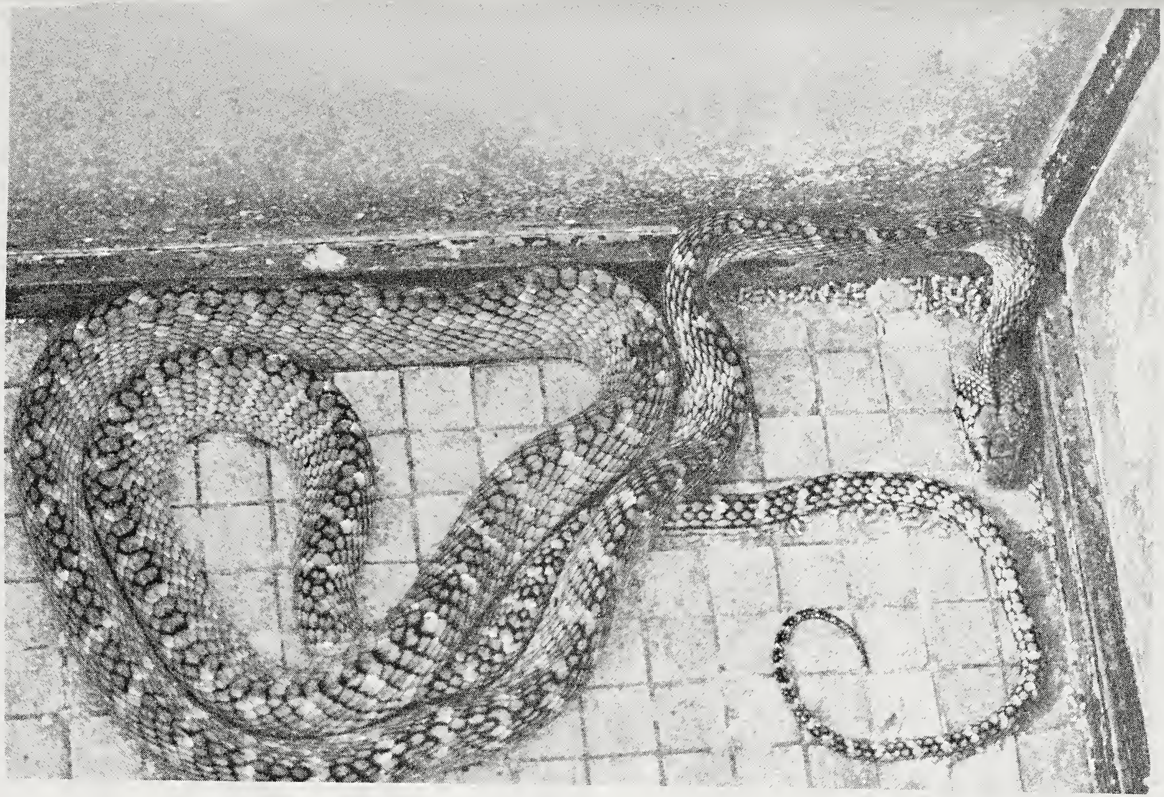

Fig. 2. Dorsal view of the lectotype of *Boiga saengsomi* in life, taken in 1989. Blotches and light crossbands much accentuated in this photograph; see text.

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Thai Zoological Center, Pata Zoo, 630/253 Phrapinklao Road, Bangkok, 10700, Thailand (WN); 695/17 Pracharaj Road, Soi Homhual, Bangkok, 10800,Thailand (MJC); Department of Environmental, Population and Organismic Biology, University of Colorado, Boulder, Colorado, 80309-0334 U.S.A. (HMS); Department of Psychology, ibid., 80309-0345 (DC).

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NOTES ON REPRODUCTION IN THE FALSE WATER COBRA (*HYDRODYNASTES GIGAS*)

Floyd E. Hayes

Abstract

The courtship and mating behavior of a wild pair of false water cobras (*Hydrodynastes gigas*) is described from Paraguay, and compared with a previous report on captive snakes. The behavior of wild snakes was similar to that of captive individuals, differing mainly in that the chase prior to mating was more prolonged and vigorous; the possibility of the chase playing a role in sexual selection is suggested. Mensural data are reported for a clutch of 22 eggs. Of 23 reported clutches, mean clutch size is 17.2 eggs (SD = 8.84; range = 5-42).

The false water cobra (*Hydrodynastes gigas*) is a large colubrid snake inhabiting wetland areas in central South America. Courtship and mating in captivity were reported by Campbell and Murphy (1984) and described by Bels (1987). Vogel (1958), Kopczynski (1974), Campbell and Murphy (1984) and Honegger (1984) reported information on egg clutches and hatchlings in captivity, and several aspects of its biology have been summarized by Honegger (1984). However, as with many snakes, a paucity of information exists on the natural history of this species in the wild. This paper describes an observation of courtship and mating by a wild pair of false water cobras, reports mensural data for a clutch of 22 eggs and briefly summarizes information on reproductive output.

Courtship and Mating

At about 1620 on 18 August 1988, I observed two large false water cobras rapidly chasing each other through shallow water (0-5 cm deep) in a flooded field near Bahía Negra, Department of Alto Paraguay, Paraguay. One snake, presumably the female, appeared to be fleeing while the second snake, presumably the male, was pursuing it. Whenever the male came alongside the female, the female would suddenly change course at about a 90° angle, and the pursuing male appeared to attempt hooking the body of the female with its mid-trunk section. After several consecutive zig-zag chases covering ca. 20 m, the two snakes abruptly stopped at an elevated muddy area, about 9 m from me, at 1621, with the large male (ca. 2.0 m total body length) resting semi-coiled on top of the smaller female (ca. 1.75 m) in a manner similar to Fig. 1 of Bels (1987).

I then watched through 8x35 binoculars as the male began rubbing its chin slowly along the dorsal surface of the female from the middle of its body toward the head; during this period the tails of the snakes were not aligned. When the head of the male reached a point about 13 cm behind the snout of the female, the tails of the snakes intertwined and, at 1624:40, copulation was attempted, as evidenced by the twisting tails and cephalocaudal waves passing along the posterior trunk of the male (tail-search copulatory attempt, in terminology of Gillingham (1979), marking end of tactile-chase phase and beginning of tactile-alignment phase). The copulation attempt was brief, lasting < 5 sec.

Afterwards, the male rubbed its chin further back along the dorsal surface of the female's neck for about 1 min, and then rested its head once again behind the head of the female just prior to a second copulatory attempt at 1626. This was followed by further chin rubbing and a third attempt at copulation at 1629:30. The latter two copulatory attempts were also short, each of < 5 sec duration. During these copulatory attempts I was unable to determine whether or not intromission was achieved. After the third copulatory attempt the snakes rested motionless until 1634, when the male suddenly rushed several m away from the female and then slowly wandered away. The female rested in the same spot for several more minutes before slowly crawling away in a different direction.

I observed the following behavioral acts described by Gillingham (1979, 1987): chase, mount, dorsal body looping, chin rubbing, dorsal advance, cephalocaudal waves, tail-search copulatory attempt and discontinuation. A total of 13 min elapsed between mounting and dismounting of the female by the male. Throughout this period the snakes showed no evidence of being aware of my presence.

My observations of courtship and mating in the false water cobra were similar to those of Bels (1987) in the sequence and display of behavioral acts. My observations differed from those of Bels (1987) primarily in that the relatively high-speed chase that I observed (obviously impossible to observe in the confines of a terrarium) was prolonged and vigorous. Also, my observation took place in the late afternoon, whereas all 22 courtship sequences observed by Bels (1987) took place in the morning between 0800-1100. Courtship in the wild presumably occurs opportunistically throughout the day. Furthermore, the males in Bels's (1987) study often mated the same females. The quickness with which the male dismounted from the female during my observation and the different directions headed by the two snakes suggest that repeated matings between the same individuals may be an artifact of captivity.

The copulatory attempts that I observed were probably all unsuccessful due to their brevity, because Bels (1987) reported that intromission usually lasted 35-40 min. That intromission probably did not occur is hardly surprising since Bels (1987) noted that only 15% of all copulatory attempts (N = 22) ended with copulation.

Bels (1987) suggested that individual variation in chin rubbing by males may play a role in sexual selection of males by females. The high-speed chase that I observed could also play a role in sexual selection by females in that less fit males may not be capable of keeping pace with a fleeing female.

Clutch Size and Egg Measurements

On 14 November 1988, I captured a ca. 2 m long female false water cobra at Estancia La Golondrina, Department of Presidente Hayes, Paraguay. The snake was kept in a covered plastic trash can overnight and released unharmed the following day. At the time of the snake's release a clutch of 22 eggs was discovered at the bottom of the trash can. The preserved eggs are deposited in the herpetological collection of the Museo Nacional de Historia Natural del Paraguay in San Lorenzo. Mensural data of the eggs are given in Table 1. The weight of the eggs was correlated with both length ($r = 0.588$, $P = 0.003$) and width ($r = 0.780$, $P < 0.001$), but length and width were not correlated ($r = 0.084$, $P = 0.70$).

Table 1. Mensural data for a clutch of 22 eggs laid by a false water cobra.

Variable	Mean	SD	Min	Max
Weight (g)	41.7	5.9	30.0	50.0
Length (mm)	59.3	5.5	47.5	70.0
Width (mm)	36.4	2.8	32.0	42.0

Vogel (1958), Kopczynski (1974), Campbell and Murphy (1984) and Honegger (1984) reported data on 22 clutches produced by captive false water cobras in Germany, Poland and the United States. Including the clutch herein reported, the mean clutch size is 17.2 eggs (SD = 8.84; range = 5-42). The mean weight (in g) of eggs for three clutches reported by Campbell and Murphy (1984) were 52.6 (N = 6), 50.7 (N = 8) and 41.9 (N = 11); and for two clutches reported by Honegger (1984), 40.6 (N = 17) and 41.7 (N = 18). There is a significant negative correlation between clutch size and mean egg weight (r = -0.832, N = 6, P = 0.02); however, more data are needed.

Clutches reported by Kopczynski (1974) were deposited during the months of January, May, August, and December; clutches reported by Campbell and Murphy (1984) were deposited in October and November; clutches reported by Honegger (1984) were deposited during February through July. The clutch herein reported was deposited during the austral spring (November), presumably the season when egg laying of wild snakes normally takes place.

Acknowledgments

The trip to Bahía Negra was funded by a grant-in-aid of research (on the avifauna of the region) from Sigma Xi; the trip to Estancia La Golondrina was funded by Evany. This study was conducted while I was employed by the United States Peace Corps. The Graduate School of Loma Linda University paid for interlibrary loans. My appreciation is extended to these organizations for supporting my studies in Paraguay.

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ERATA

The following corrections and additions should be included for the June 30 issue (pp 43-89). The author is appreciative of the efforts of Harold A. Dundee for pointing these out.

-page 50, paragraph 3, line 4
"1731-1747" should read "1731-1743"

-page 50, paragraph 4, line 5
"(1766)" should read "(1758)"

-page 52, paragraph 4, line 4
"which has" should read "which had"

-page 53, paragraph 1, lines 11 and 12
"rejects" should read "rejected"

-page 53, paragraph 1, line 14
" is to be" should read "was to be"

-page 59, paragraph 2, line 2
"compared to" should read "compared with"

-page 60, paragraph 1, line 2
"suggest" should read "suggests"

-page 60, paragraph 4, line 6
"long headed" should read "long-headed"

-page 60, paragraph 4, line 7
"short headed" should read "short-headed"

-page 60, paragraph 5, line 3
"neotype is" should read "neotype was"

-page 62, legend
"long headed" should read "long-headed"

-page 77, paragraph 6, line 2
"reports" should read "reported"

-page 77, paragraph 6, line 5
"notes" should read "noted"

-page 78, paragraph 1, line 5
"observes" should read "observed"

-page 80, paragraph 7, line 2
"Meylon" should read "Meylan"

-page 81, line 11
"1859: 1-13" should read "1859: 1-35"

-page 81, line 32
"Essai dune" should read "Essai d'une"

-page 83, line 21
"zoologicus" should read "zoologiques"

-page 84, line 26
"Pats" should read "Parts"

-page 84, line 32
"Latreill" should read "Latreille"

-page 86, line 14
"reptiles" should read "Reptiles"

-page 89, line 6
"Saughtier und Vogel ein" should read "Saugethiere und Vogel. Ein"

-page 89, ommission
Williams, E. 1969. The ecology of colonization as seen in the zoogeography of anoline lizards on small islands. Qtrly. Rev. Biol. 44: 345-389.

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Volume 27 Number 4 December 1991

SOME AMPHIBIANS AND REPTILES FROM CAHUACAN, TRANSFIGURACION AND VILLA DEL CARBON, STATE OF MEXICO. WITH GENERAL COMMENTS ON THEIR ECOLOGY

Aurelio Ramírez-Bautista, Enrique Godínez-Cano, and José L. Camarillo

Abstract

A total of 19 species of reptiles and amphibians is reported from oak and oak-coniferous forest in Cahuacán, Transfiguración, and Villa del Carbón, State of México; of those 19 species, 14 are known from Cahuacán, 11 from Villa del Carbón and 8 from Transfiguración. The species composition and number of individuals were compared to microhabitat types. Diversity indices were calculated (Cahuacán, 0.81; Villa del Carbón, 0.87 and Transfiguración, 0.84).

The mountains in the State of México that border the Valley of México (Basin of México) include a varied herpetofauna with 34 species (11 amphibians and 23 reptiles according to Uribe *et al.* 1983); this represents 2.4% of the Mexican herpetofauna as the latter was estimated by Smith and Smith (1976), with 227 and 1210 species of amphibians and reptiles respectively; other areas studied embrace 1.72% to 12.20% of the Mexican herpetofauna (Taylor, 1953; Duellman, 1961; Dixon *et al.*, 1972; Martín del Campo and Sánchez-Herrera, 1977; Wilson and McCranie, 1979). Several works have dealt with the herpetofauna of the area. Among them, Díaz (1961) and Lara *et al.* (1979) covered taxonomic aspects. Other papers have addressed ecological aspects of some species or communities of reptiles and amphibians (Casas-Andreu *et. al.*, 1980; Ramírez-Bautista *et al.*, 1979; Lara and Ortega, 1980) or reproduction and feeding habits (Gallina, 1980; Guillette, 1981, 1983; Guillette and Casas-Andreu, 1980, 1987; Gutiérrez and Sánchez, 1986; Méndez *et al.*, 1988).

The above mentioned research has been carried out in the mountains located south of México City (Fig. 1), where the dominant vegetation is comprised of oak, coniferous or mixed communities (Rzedowsky *et al.*, 1964).

Due to the scarcity of herpetological data from the northern portion of the state of México and to the importance of that area, now endangered by human activity, we undertook this study, focusing on faunistic and some ecological aspects such as species diversity of amphibians and reptiles from apparently similar habitats in three places (in temperate forest) and distribution of species by vegetation types (and by microhabitats within each type).

Materials and Methods

The study sites are located on the transvolcanic Mexican belt. Altitudes range from 2500 to 2750 m with an average of 2600 m. The sites are Transfiguración (19° 39' 43' N and 99° 25' 11' W), Cahuacán (19° 37' 48" N and 99° 24' 54" W) and Villa del Carbón (19° 44' 33" N and 99° 27' 14" W).

Geologically, the area includes volcanic rocks such as breccia, rhyolite and tufa. Soils are of the luvisol type.

Some streams arise from the higher mountains of the Sierra de las Cruces and creeks such as Las Moras, Tepozanes and Cuauhtitlán flow northward (Detenal, 1981).

The climate is temperate, with a summer rainy season and low winter precipitation, with subclimates which vary in humidity levels (García, 1981).

The number of amphibian and reptile specimens (total 411) and number of species were recorded from three localities from April to July in 1980, to determine the composition of the herpetofauna of the three areas. Seven samples were taken as follows: 2 in Transfiguración, 2 in Villa del Carbón and 3 in Cahuacán. Collecting activity was carried out over roughly 1000 to 1700 hs.

Sampling within each area involved a transect 2 km long and 10 m wide. Data included the total number of individuals of each species seen as well as notes on the type of microhabitat occupied.

The herpetofaunal diversity among the study sites was compared by means of Shannon-Wiener's formula (Smith, 1980):

$$D = \sum_{i=1}^{n} (p_i \log p_i)$$

where n = is number total of species recorded in the community and p_i = record probability of the species i.

The equitability level in the distribution of the records by species was measured with the following expression:

$$Eq = D/Dmax$$

where Dmax = log n.

Results and Discussion

Nineteen species of amphibians and reptiles inhabit the area, representing 14 genera and 9 families (Table 1).

At Villa del Carbón we found 3 species of amphibians and 8 of reptiles; in Transfiguración, 3 amphibians and 5 reptiles; and at Cahuacán, 5 amphibians and 9 reptiles. The most common species throughout the three areas were *Sceloporus s. aeneus* (115 individuals), *S. grammicus* (95), *Conopsis biserialis* (46), and *Pseudoeurycea leprosa* (33); other species were found only in one or two of the areas and their abundance was lower (e.g. *Pituophis deppei* in Villa del Carbón; *Thamnophis cyrtopsis cyrtopsis* in Cahuacán; *Hyla plicata* in Transfiguración and Cahuacán (see Table 2).

Distribution of the herpetofauna by vegetation was studied chiefly in two communities (Table 3): oak-coniferous forest and oak forest, with 19 and 8 species respectively. The most common species in both communities were: *Pseudoeurycea leprosa*, *Sceloporus a. aeneus*, *Sceloporus grammicus*, *Eumeces copei*, *Conopsis biserialis*, and *Storeria storerioides*. The community with the greatest number of species and individuals was oak-coniferous forest.

A conventional microhabitat classification was proposed for each species, according to the sites of capture of individuals in the three areas. Cahuacán (Fig. 2B) showed the greatest number of microhabitat types, 12, occupied by several species (from one to four). "Under log" was the microhabitat where the highest number of species of amphibians occurred (*Ambystoma altamiranoi*, *Pseudoeurycea belli*, *Pseudoeurycea leprosa*, and *Chiropterotriton chiropterus*). Other microhabitats were "Among leaves" (*Sceloporus a. aeneus*, *Storeria storerioides*, and *Crotalus triseriatus*); "Grass" (*S. a. aeneus*, *Conopsis biserialis*, and *Storeria storerioides*); and "Under rocks" (*Eumeces copei*, *Conopsis biserialis*, and *Thamnophis cyrtopsis cyrtopsis*); four microhabitat types were occupied by two species of amphibians and reptiles each (*Chiropterotriton chiropterus*, *Hyla plicata*, *S. a. aeneus*, *Barisia imbricata*, *Thamnophis cyrtopsis cyrtopsis* and *T. scalaris*), and the remainder of the microhabitats (4) by one species each (*Sceloporus grammicus*, and *Pseudoeurycea leprosa*).

Transfiguración (Fig. 2B) presented the lowest number of microhabitat types (5), being "Dead leaves" where the highest number of species occurred (*Pseudoeurycea leprosa*, *Chiropterotriton chiropterus*, *Sceloporus a.*

aeneus, *Conopsis biserialis*, and *Storeria storerioides*). "Logs" was the second with four species (*Chiropterotriton chiropterus*, *S. grammicus*, *Eumeces copei*, and *C. biserialis*); "Open Ground" had three species (*Hyla copei*, *S. a. aeneus*, and *S. grammicus*); and the remainder, "Under Rocks" and "Century plant" showed one species each (*Pseudoeurycea leprosa* and *S. grammicus*, respectively).

At Cahuacán (Fig. 2A) the microhabitat types "Under rocks", "Grass", and "Tree" were exploited by the greatest (compared with the remainder of microhabitat types) number of individuals, of four species (*S. a. aeneus*, *S. grammicus*, *E. copei*, and *Conopsis biserialis*), whereas in Transfiguración "Dead leaves", "Open ground", and "On logs" were those occupied by the highest number of individuals, of three species (*S. a. aeneus*, *S. grammicus*, and *Conopsis biserialis*), and at Villa del Carbón the numbers of individuals were distributed more nearly equally among species (see Fig. 4).

The frequency of occurrence of the species is different in each of the three areas sampled (see Table 2, Fig. 4), although total species richness was more or less similar (Cahuacán 14,Villa del Carbón 11, and Transfiguración 8).

In Cahuacán the species that were recorded with highest frequency (> 18 records) were *S. a, aeneus*, *S. grammicus*, *E. copei*, *C. biserialis*; Villa del Carbón (> 10 records) *S. a. aeneus*, *S. grammicus*, *S. torquatus*, and *A. altamiranoi*; and in Transfiguración (> 15 records) *S. a. aeneus*, *S. grammicus*, *C. biserialis* and *P. leprosa*.

In all three areas lizards constituted the most conspicuous element (Fig. 4). *S. a. aeneus* and *S. grammicus* were the most frequently encountered in the study areas.

Although our sample is limited, the structure of the communities is nevertheless evident. Table 2 and Fig. 4 show that the most abundant records were provided by 5 species (*S. a. aeneus*, *S. grammicus*, *C. biserialis*, *E. copei*, and *Pseudoeurycea leprosa*) in Cahuacán and Transfiguración, whereas in Villa del Carbón the distribution of individuals among species in our samples is more nearly even. Recent literature shows that species in tropical forests have a tendency toward a high equality (Peet, 1975; Maiorana, 1976; and Sánchez and López-Forment, 1988), whereas those in temperate forests have a tendency to low equality, correlated with altitude (Pianka, 1969; Scott, 1976; and Heatwole, 1982). Thus, in the study area were two species of lizards that showed the highest percentage (47.6 – 59.9%, see Table 3). That suggests that these areas represent natural communities of amphibians and reptiles, since the number of individuals of a few species increases with the altitude, whereas others are rare (Heatwole, 1982).

The diversity indices calculated for the study sites (Villa del Carbón 0.87, Transfiguración 0.84, and Cahuacán 0.81) were somewhat similar (Table 4). The small discrepancies seem to be attributable to different proportions of individuals recorded of each species in the area samples (Table 2 and Fig. 4). Equitability values in the three areas were 0.83, 0.77, and 0.73 (Table 4). Equitability values indicate how the individuals of the three zones are distributed among species; thus in Villa del Carbón (Fig. 4), the number of individuals among species was distributed more nearly equally than in Cahuacán and Transfiguración. Therefore, Villa del Carbón had a slightly higher value, due to the more nearly equal distribution of the individuals there than in other sites (Tables 2, 4). Similarity of the diversity indices in the three localities may be due to the fact that the habitat composition generally includes the same structural layers. The environmental factors such as altitude, vegetation type, temperature, moisture and precipitation may also be similar; since the three areas occur at the same altitude, these factors can be related to the distribution of individuals among species (Swan, 1952; Scott, 1976; Arévalo and Ramírez-Bautista, 1986).

However, Cahuacán (Table 2, and Fig. 3B) showed a higher species richness – 14 of 19 species (74.0%) of the herpetofauna - than the other two areas (58.0 and 42.0% in Villa del Carbón and Transfiguración respectively). This difference in number of species may be influenced by the greater number of microhabitats (Cahuacán 12, Villa del Carbón and Transfiguración 5). Differences in species richness also may be due to the alteration of the environment produced by man, since the disturbance apparently favors the increase of species and the number of individuals, as occurs in Cahuacán. This factor is pointed out in other herpetological studies (Lemos and Rodríguez, 1984; Gutiérrez and Sánchez, 1986; Arévalo and Ramírez-Bautista, 1986; Sánchez and López-Forment, 1988). Another factor is the flexibility of certain species, such as *Sceloporus grammicus*, which used the greatest number of microhabitat types in each zone. Its flexibility is reflected by its wide distribution, ranging vertically from sea level to 4500 m (Swan, 1952; Smith, 1980; Arévalo, 1988) and horizontally from Oaxaca to Texas.

The herpetofauna of this area is characteristic of the temperate zone (Dunn, 1931; Stuart, 1957). The most abundant amphibian was found to be *Pseudoeurycea leprosa* (33 specimens), the most abundant lizards *Sceloporus aeneus*, *S. grammicus* and *Eumeces copei* (115, 95, and 26 individuals respectively) and the most abundant snakes *Conopsis biserialis*, *Storeria storerioides* and *Thamnophis cyrtopsis* (46, 16, and 10 organisms respectively).

Several species were shared between two or all three localities studied, but some species were confined to a particular environment, such as *Barisia imbricata*, *Thamnophis scalaris scaliger* and *Crotalus triseriatus*, to oak-coniferous communities (Table 3).

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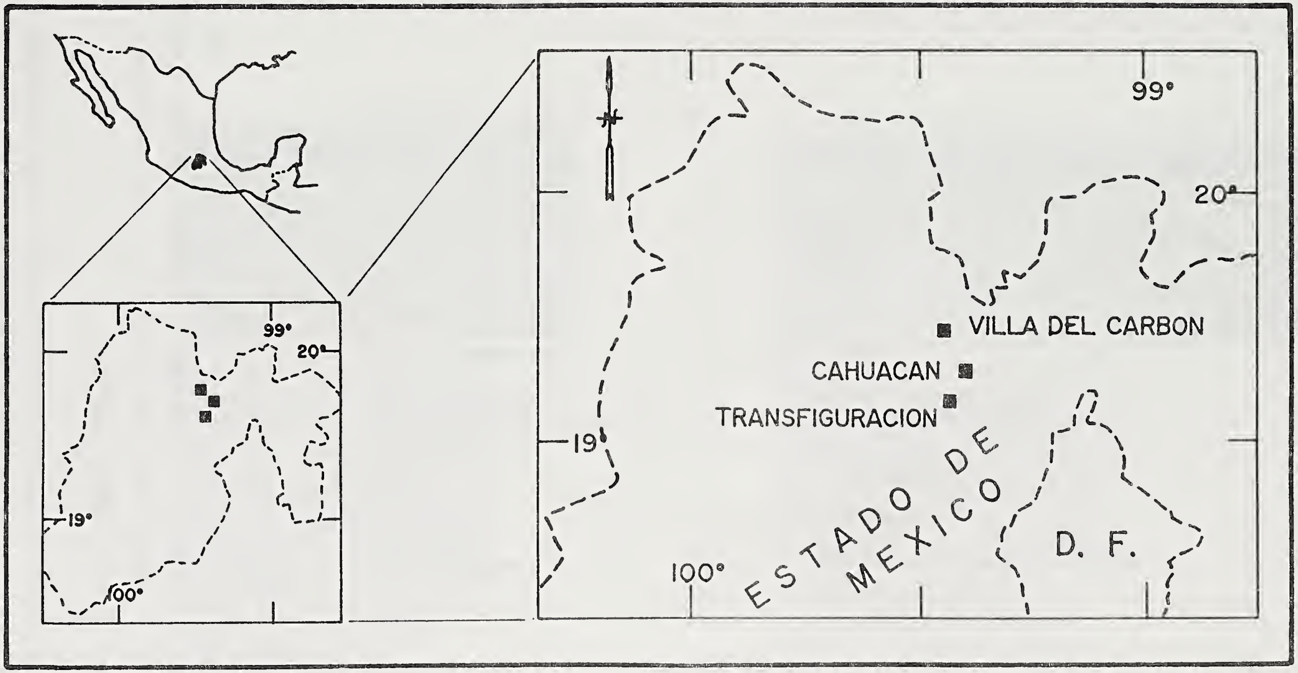
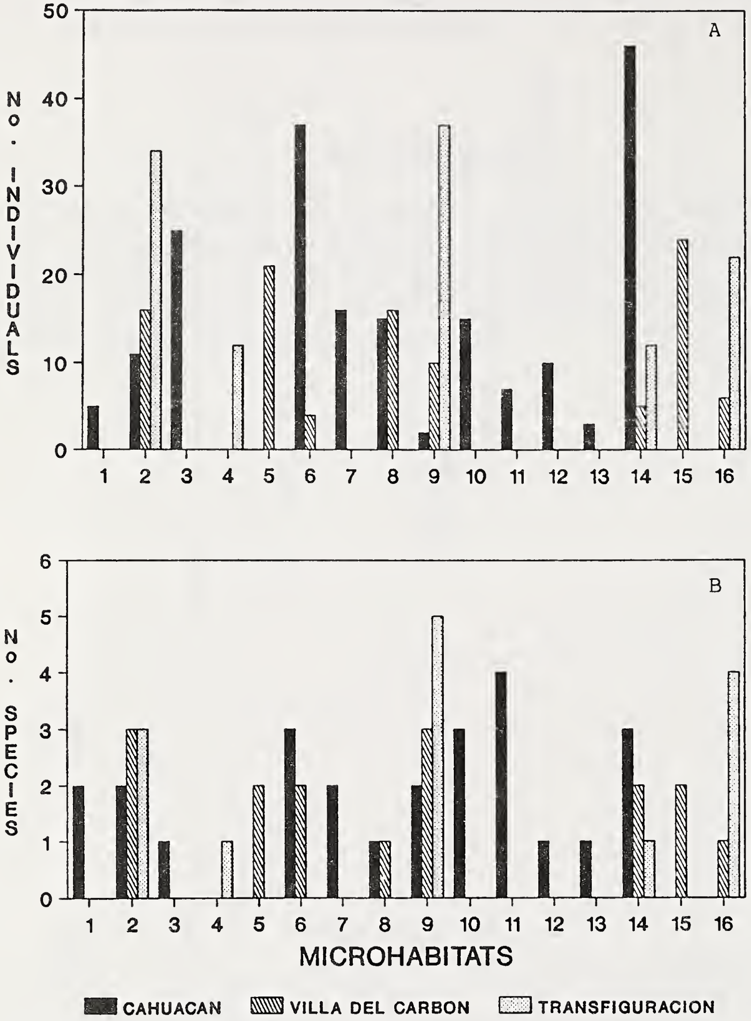


Fig. 1. Geographic location of the study area.



1= Ground hole
2= Open Ground
3= Tree
4= Century plant
5= Stream
6= Grass
7= Bunch grass
8= Dead trunk
9= Dead leaves
10= Among leaves
11= Under log
12= Rock
13= Among logs
14= Under rocks
15= Among rocks
16= On log

Fig. 2. Number of individuals (A) and species (B) occurring in each microhabitat type at Cahuacán, Villa del Carbón and Transfiguración.

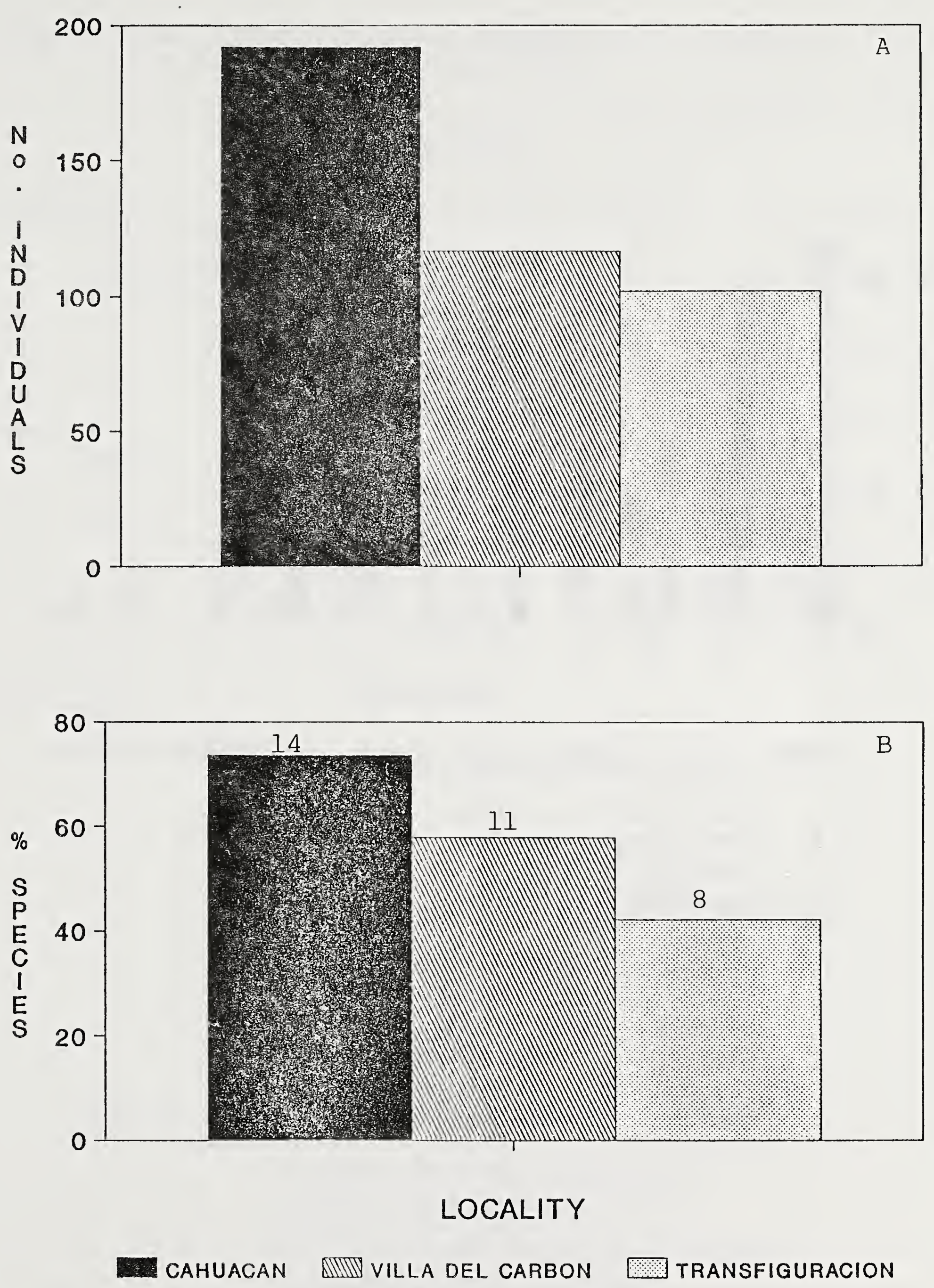
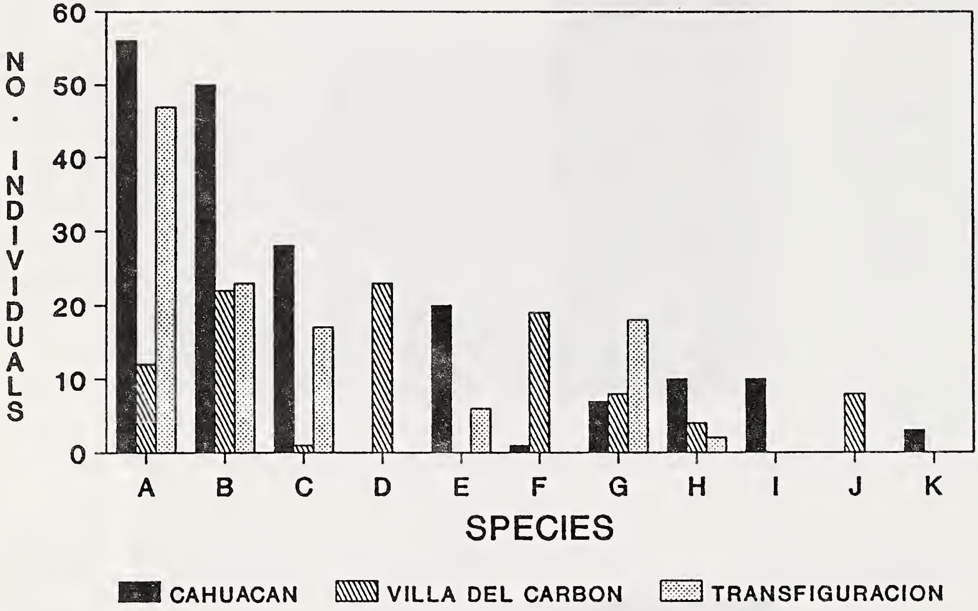


Fig. 3. (A) Relation of number of individuals of herps, and (B) proportion of species in the study area. Number above bars indicates number of species.



A = *Sceloporus a. aeneus*
B = *Sceloporus grammicus*
C = *Conopsis biserialis*
D = *Sceloporus t. torquatus*
E = *Eumeces copei*
F = *Ambystoma altamiranoi*
G = *Pseudoeurycea leprosa*
H = *Storeria storerioides*
I = *Thamnophis cyrtopsis cyrtopsis*
J = *Phrynosoma o. orbiculare*
K = *Crotalus t. triseriatus*

Fig. 4. Histogram of frequency record of species of amphibians and reptiles from Cahuacán, Villa del Carbón and Transfiguración.

Table 1. List of species of the areas of Transfiguración, Cahuacán and Villa del Carbón, State of México, México

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AMPHIBIA

- Urodela
  - Ambystomatidae
    - Ambystoma altamiranoi (Dugès)
  - Plethodontidae
    - Pseudoeurycea belli (Grey)
    - Pseudoeurycea leprosa (Cope)
    - Chiropterotriton chiropterus (Cope)

- Anura
  - Hylidae
    - Hyla plicata Brocchi
  - Ranidae
    - Rana spectabilis Hillis and Frost

REPTILIA

- Squamata
  - Sauria
    - Anguidae
      - Barisia imbricata imbricata (Wiegmann)

    - Iguanidae
      - Phrynosoma orbiculare (Linnaeus)
      - Sceloporus aeneus aeneus Wiegmann
      - Sceloporus grammicus microlepidotus Wiegmann
      - Sceloporus scalaris scalaris Wiegmann
      - Sceloporus torquatus torquatus Wiegmann

    - Scincidae
      - Eumeces copei Taylor

  - Serpentes
    - Colubridae
      - Conopsis biserialis Taylor and Smith
      - Pituophis deppei deppei (Duméril)
      - Storeria storerioides (Cope)
      - Thamnophis cyrtopsis cyrtopsis (Kennicott)
      - Thamnophis scalaris scaliger (Jan)

    - Viperidae
      - Crotalus triseriatus triseriatus (Wagler)

Table 2. List of species observed and relative representation at each locality.

	PERCENTAGE OF TOTAL HERPETOFAUNA		
SPECIES	74% C	42% T	58% V
Ambystoma altamiranoi	1		19
Pseudoeurycea belli	1		
Pseudoeurycea leprosa	7	18	8
Chiropterotriton chiropterus	2	3	
Hyla plicata	1	1	
Rana spectabilis			2
Sceloporus grammicus microlepidotus	50	23	22
Sceloporus aeneus aeneus	56	47	12
Sceloporus scalaris scalaris			2
Sceloporus torquatus torquatus			23
Phrynosoma orbiculare orbiculare			8
Barisia imbricata imbricata	2		
Eumeces copei	20	6	
Conopsis biserialis	28	17	1
Pituophis deppei deppei			1
Storeria storerioides	10	2	4
Thamnophis cyrtopsis cyrtopsis	10		
Thamnophis scalaris scaliger	1		
Crotalus triseriatus triseriatus	3		
	N=192	N=117	N=102

C = Cahuacán T = Transfiguración V = Villa del Carbón

Table 3. Species distribution in two habitats of Cahuacán, Transfiguración and Villa del Carbón

	HABITAT	
SPECIES	OAK FOREST 42% of total number of species (8)	OAK-CONIFEROUS 100% of total number of species (19)
Ambystoma altamiranoi		20 (6.8%)
Pseudoeurycea belli		1 (0.34%)
Pseudoeurycea leprosa	18 (15.5%)	15 (5.1%)
Chiropterotriton chiropterus	3 (2.5%)	2 (0.68%)
Hyla plicata	1 (.80%)	1 (0.34%)
Rana spectabilis		2 (0.68%)
Phrynosoma orbiculare orbiculare		8 (2.74%)
Sceloporus aeneus aeneus	41 (40.2%)	68 (23.1%)
Sceloporus grammicus microlepidotus	23 (19.7%)	72 (24.5%)
Sceloporus scalaris scalaris		2 (.68%)
Sceloporus torquatus torquatus		23 (7.8%)
Eumeces copei	6 (5.1%)	20 (6.8%)
Barisia imbricata imbricata		2 (.68%)
Conopsis biserialis	17 (14.5%)	29 (9.6%)
Pituophis deppei deppei		1 (.34%)
Storeria storerioides	2 (1.7%)	14 (4.7%)
Thamnophis cyrtopsis cyrtopsis		10 (3.4%)
Thamnophis scalaris scaliger		1 (.34%)
Crotalus triseriatus triseriatus		3 (1.0%)
	N=117	N=294

Table 4. Values of diversity indices and equitability of the herpetofauna of the study areas.

LOCALITY	DIVERSITY	EQUITABILITY	NUMBER OF SPECIES
Villa del Carbón	0.87	0.83	11
Transfiguración	0.84	0.77	8
Cahuacán	0.81	0.73	14

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EFFECTS OF RATTLESNAKE (*CROTALUS VIRIDIS OREGANUS*) ENVENOMATION UPON THE MOBILITY AND DEATH RATE OF LABORATORY MICE (*MUS MUSCULUS*) AND WILD MICE (*PEROMYSCUS MANICULATUS*).

B. F. Kuhn, M. J. Rochelle, and Kenneth V. Kardong

Abstract

Previous investigators have reported significant differences in distance traveled by wild mice compared to laboratory mice (*Mus musculus)* following envenomation by adult rattlesnakes. This study found significant difference in death rate between laboratory mice (*Mus musculus*) and wild mice (*Peromyscus maniculatus*) following envenomation but no poststrike differences in distance traveled. Further, no significant differences in strike performance were found between envenomated wild mice from two distinct habitats, one devoid of rattlesnakes and one approximately 30 km away, where rattlesnakes (*Crotalus viridis oreganus)* are common. We did find broad variations in distance traveled and latency to death. Such variation in envenomation performance suggests that there is great uncertainty about strike results. The prey may die quickly, close to the snake, or scamper off a considerable distance. The chemoreceptive abilities of adult rattlesnakes must be designed to accommodate these variations during prey capture.

The feeding behavior of rattlesnakes typically involves location, strike, release, and subsequent recovery of prey (Klauber, 1972; Chiszar and Radcliffe, 1976; Chiszar et al., 1981). Envenomation not only kills the prey, but it must also result in immobilization of the prey within the recovery range of the snake (Chiszar *et al.*, 1977; Estep *et al.*, 1981; Golan *et al.*, 1982). Measurements of this envenomation effectiveness show that different species of mice have different susceptibilities to the same venom (Minton, 1969; Russell, 1980; Dewit, 1982). These differences seem especially evident between wild and laboratory mice (Hayes and Galusha, 1984). The first purpose of this study then was to determine if differences of death rate and immobilization distances occur in laboratory compared to wild mice struck by the rattlesnake, *Crotalus viridis oreganus*. Further, differences in natural predation pressure by rattlesnakes might result in different susceptibilities by prey to the bite. Thus the second purpose of this study was to see if differences within wild mice exist between those from mice populations *with* and those *without* rattlesnake predation pressure.

Materials and Methods

Subjects. Twelve rattlesnakes (*Crotalus viridis oreganus*) were used in the study. Subjects were both male and female adult snakes, ranging in size from 35 cm to 65 cm. All of the rattlesnakes had been held in captivity for a minimum of one year, and were fed laboratory-reared rodents (*Mus musculus*) on a bi-monthly schedule. Snakes were housed individually in glass terraria (50 x 27 x 30 cm) with newspaper floor coverings and glass water dishes. Daily photoperiods began at 0800 hrs. and ended at 2000 hrs. The temperature of the room was held relatively constant at all times (27.5° C ± 2).

Procedures. Each snake was run in three trials (treatments). During each trial the snake was placed into a circular arena (diameter 134 cm, depth 46.5 cm) and allowed to acclimate for five minutes. Overhead room lights were off and the test arena was illuminated by two lamps on opposing sides of the arena, each with a 75 watt bulb. Following acclimation, a pre-weighed mouse was introduced via forceps to an opposite side of the arena from the snake. Upon introduction of the mouse, an overhead VHS video system recorded ensuing events. Later review of the recordings was used to determine death rate time from strike to last muscular twitch) and distance traveled by the mouse following envenomation. A 10 cm square grid system was drawn upon the butcher-paper floor covering of the arena. From review of the video, the path followed by the mouse was traced and the total distance (to nearest cm) scored.

Each snake was administered three treatments each separated by at least seven days. In one treatment, laboratory white mice (*Mus musculus*) were presented as prey; in the second and third treatments wild mice (*Peromyscus maniculatus*) were presented, one having been live-trapped in an area devoid of rattlesnakes and the other from an area 30 km away where this rattlesnake species is common. Ponderosa pine (*Pinus ponderosa*) and sagebrush (*Artemisia tridentata*) predominate in each habitat, respectively. All wild mice were live trapped no more that 10 days prior to use, and all mice were of mixed sex, ranging in size from 13–27.5 gm. Each snake was permitted as many strikes as necessary until successful envenomation. Thereafter, the snake was removed from the arena so as to prevent any further interaction between the predator and prey. Treatments were thus administered in a randomized block design and the results statistically examined via ANOVA (SAS statistical package, Proc GLM, Fisher's least significant difference).

Results

Wild mice from areas without rattlesnakes and wild mice from areas with rattlesnakes exhibited no differences in poststrike death rates ($P > .21$, 156.2 *vs* 79.3 s) or distances traveled ($P > 0.07$, 501.9 *vs* 229.0 cm) following envenomation. However, laboratory mice took longer to die than the lumped groups of wild mice but traveled statistically equivalent poststrike distances (Table 1, Prey 1 *vs* Prey 2 & 3). A somewhat surprising comparison emerged between the two types of wild mice compared individually to the laboratory mice. Wild mice from areas without rattlesnakes died as quickly and traveled equivalent distances to laboratory mice. But wild mice from areas with rattlesnakes died faster and traveled shorter poststrike distances (Table 1, Prey 1 *vs* Prey 3).

Table 1. Death rates and distances traveled by laboratory mice (Prey 1) and by wild mice from habitats without (Prey 2) and with (Prey 3) rattlesnakes.

		Death rate		Distance	
	N	mean(s)	range(s)	mean (cm)	range (cm)
Prey 1	12	297.4*	16-909	388.8	0.0-630.0
Prey 2	12	156.3*	30-486	501.9	74.0-1534.2
Prey 3	12	79.3	30-486	229.0	12.0-400.0
Prey 2	12	156.3	30-486	501.9	74.0-1534.2
Prey 3	12	79.3	7-371	229.0	12.0-400.0
Prey 1	12	297.4*	16-909	388.8	0.0-630.0
Prey 2 & 3	24	117.8*	7-486	364.4	12.0-1534.2
Prey 1	12	297.4*	16-909	388.8**	0.0-630.0
Prey 3	12	79.3*	7-371	229.0**	12.0-400.0

GLM: * $P < .05$ ** $P < .005$

Discussion/Conclusions

Our results differ from studies by others (Hayes and Galusha 1984), who did find that after envenomation by adult rattlesnakes (*Crotalus viridis oreganus*), wild mice (*Mus musculus*) traveled significantly farther than adult laboratory mice (*M. musculus*). We found no such significant poststrike difference in *distance* traveled. The significant difference we found was in *death rate* between laboratory and wild mice. Discrepancies between our results and others might be attributable to several differences in experimental design. Further, the site of envenomation was not controlled in our study or theirs, and represents but one factor producing differences in envenomation effectiveness (Kardong, 1986a).

Comparing wild mice types separately to laboratory mice, we discovered that wild mice from areas with rattlesnakes died faster and ran shorter poststrike distances than laboratory mice. Curiously, such significant differences did not emerge between wild mice from rattlesnake-free areas and laboratory mice. The two areas are about 1000 m different in elevation, one Ponderosa pine (rattlesnake-free) the other sagebrush (rattlesnakes). Perhaps different ecological settings for the two populations of wild mice produce mice with different susceptibilities to rattlesnake envenomations.

However, we feel that the differences between our results and other studies are not due substantially to differences in experimental design. Instead, the statistical differences are more likely the result of the substantial normal variation in envenomation effectiveness. Even within our own study where we used the same rattlesnake species and same prey species, and where testing procedures were standardized, we still discovered considerable variation in strike performance whether measured by either latency to death or by distance traveled after envenomation. Possible sources of such variation have received attention (Kardong, 1986b).

If we had run many more repetitions of our feeding trials, then additional statistical significance might have emerged in the larger data set. But, it is not the absence of significant differences we wish to emphasize. Rather we wish to draw attention to the great individual variation in strike performance. Apparently such variation is part of the normal uncertainty following the predatory strike. Sometimes the prey dies quickly close to the snake; other times it scampers a great distance (up to 1534 cm). This variation in envenomation effectiveness seems to characterize rattlesnake predatory behavior (our study and others). Consequently, the predatory behavior and hunting strategy of the rattlesnake might be expected to be designed to address this variation or uncertainty in envenomation success.

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THE STATUS OF THE SOUTHERN MEXICAN LIZARD *SCELOPORUS CARINATUS*

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Abstract

Although a slight overlap in diagnostic characters occurs in *Sceloporus siniferus* with both *S. carinatus* and *S. squamosus*, it is regarded as specifically distinct from them, geographically isolated and distinguished most reliably by possession of two canthals. Both of the other species always have one canthal, have grossly parapatric ranges, and do not intergrade; *S. squamosus* has 2-6 femoral pores. *S. carinatus* 8-13.

As modified by Cole (1978), through allocation of *Sceloporus ochoterenae* Smith to the *jalapae* group, the *siniferus* group of the genus remains with but three species, as understood at present: *S. carinatus* Smith, *S. squamosus* Bocourt, and *S. siniferus* Cope. The latter is represented by two subspecies: *S. s. siniferus* of lowlands from Guerrero to the Isthmus of Tehuantepec, with an isolated population in extreme southeastern Chiapas and adjacent Guatemala, and *S. s. cupreus* Bocourt, in the highlands of Oaxaca. *S. carinatus* occurs in the headwater valleys of the Rio Grijalva from extreme northeastern Oaxaca through the Central Depression of Chiapas (Johnson, 1989) into adjacent Guatemala and headwaters of the Rio Negro. *S. squamosus* is largely limited to Pacific slopes, extreme southeastern Chiapas to Costa Rica, but extending into Atlantic drainages in Guatemala and Honduras.

These three species therefore have largely allopatric ranges; sympatry may occur only of *S. squamosus* and *S. siniferus* in a very limited area of extreme southeastern Chiapas and adjacent Guatemala. No selection therefore occurs elsewhere favoring character displacement.

The character states that distinguish the three species are number of canthals (two in *S. siniferus*, one in the others) and, comparing only the two with single canthals, number of femoral pores and number of dorsal scales, interparietal to base of tail (2-6 and 28-37, respectively, in *S. squamosus*, 8-13 and 38-44 in *S. carinatus*. It should be noted that *S.*

siniferus broadly overlaps both of the other species in both counts (3-14 and 31-46, respectively).

Three specimens of the *siniferus* group in the University of Colorado Museum (UCM) from peripheral localities extend known ranges of variation and distribution and require re-evaluation of the taxonomic ranks of all three taxa now recognized.

1. Rio Negro, Oaxaca

A single adult female (UCM 41125, 52 mm s-v) was taken by that legendary explorer, naturalist and horticulturist Thomas B. MacDougall, May 5-8, 1967, on the Rio Negro, Oaxaca, a tributary of the Rio Grijalva (mapped in MacDougall, 1971: 86). He was an incredible 70 years of age when he undertook the rigorous journey afoot on which the specimen was obtained, although he had tramped for many years into many otherwise inaccessible regions of Oaxaca (Smith, 1974). His 1971 article documents his amazing intrepidity.

This unique specimen has 32 dorsals, 8 nape rows, 7 rump rows, 8-9 femoral pores, and one canthal. Since it was found in the upper Rio Grijalva drainage, where all specimens of *S. carinatus* have been taken (except in Guatemala, where they have been found in the headwaters of an adjacent Rio Negro, a tributary of the Rio Usumacinta; Stuart, 1963: 70), it is here regarded as a representative of that species, despite its very low dorsal scale count. The latter therefore extends the known range for that character in the species from 38-44 to 32-44. For species related to *S. siniferus*, that is not a particularly suspicious range; in *S. siniferus* it is 31-46, although two subspecies are represented. Even in one locality or limited region, however, the range in the latter species is usually great: at Tonalá, Chiapas, for example, it is 32-39, in 19 specimens; in Guerrero, also 32-39, in 29; and in the vicinity of Tehuantepec, Oaxaca, 34-46 in 27.

The sole distinctive feature of *S. carinatus*, in comparison with *S. squamosus*, is therefore its more numerous femoral pores (8-13 vs 2-6).

The Oaxaca locality here reported is the first for that state. Presumably the species is limited there to the Rio Grijalva tributaries, which barely enter the state. In Chiapas records are available as follows: 6.4 mi N Tuxtla Gutierrez (UCM 48889-90); 15.4 mi S Tuxtla Gutierrez (UCM 48891-2); Tuxtla Gutierrez (Smith, 1939: 303-5); Chiapa de Corzo (Alvarez del Toro, 1982: 22) Rancho Meyapac, Ocozocoautla (Larsen and Tanner, 1974: 15-37, fig. 11); Trinitaria (Olson et al., 1987: 31); and 1 mi NW Teopisca (Olson et al., 1987: 31).

The four UCM specimens all have 1-1 canthals, and the dorsal scales vary 38-40, nuchal rows 9-11, rump rows 8-9, femoral pores 10-13.

2. Mt. Ovando

A single adult male (UCM 39662, 54 mm s-v) was taken in October, 1940, on Mt. Ovando, Chiapas, by Eizi Matuda. The mountain is about 6 mi NE Acacoyagua, and about 3 mi E of La Esperanza, a coffee finca where Matuda lived for many years. He was a botanist who frequently collected in the mountains near his home. The specimen is somewhat soft and discolored, but its scale characters are intact. It has one canthal, 34 dorsals, 9 nape and 8 rump rows, and 11-12 femoral pores. Like the Rio Negro specimen, it has relatively large scales, but it seems merely to confirm that the dorsal scales count is more variable in *S. carinatus*, to which it is here referred, that has hitherto been understood to occur. It does, however, come from an area in which *S. squamosus* might be expected, inasmuch as that species occurs as far northwest along the coast as Pijijiapan, about 70 km northwest of Acacoyagua. However, it appears that *S. squamosus* in Chiapas is limited to low altitudes, whereas *S. carinatus* is an upland species. This is the only record of that species from the southern slopes of the Central Depression, or from the sierra that constitutes the divide. However, those slopes have been little explored herpetologically because of inaccessibility; the northern slopes, whence all other Chiapas records have come, are readily accessed by a main highway through Tuxtla Gutierrez and Comitán to the Guatemala border.

3. Mitla, Oaxaca

A single adult male (UCM 41101, 49 mm s-v) was taken by Thomas B. MacDougall in 1967 from km 619 southeast of the Mitla exit on Highway 190 to Tehuantepec, Oaxaca. It has 1-1 canthals, 40 dorsals, 11 nape and 9 rump rows, and 11-11 femoral pores. In brief, it is indistinguishable from *S. carinatus* on the basis of its external morphology. It is nevertheless here referred to *S. siniferus cupreus* (Smith and Taylor, 1959; 134-135), with which it also agrees in every respect except in having 1-1 canthals, and in the middle of whose geographic range it was found.

Although the number of canthals is the most reliable means of distinguishing *S. siniferus* (with 2-2) from the *squamosus* section of the group (with 1-1), the character is variable in the former species (apparently not in the latter section). In only three specimens, including the Mitla one,in 183 examined of *S. siniferus* , are the canthals 1-1; in three others they are 1-2, and in 177 they are 2-2. In the six exceptions, four have the first canthal fused with the subocular, which thus contacts the lateral frontalnasal. On the contrary, in all specimens of the *squamosus* section, the first and second canthals are fused with each other, excluding the subocular from contact with the lateral frontonasal. In *S. siniferus* , only no. 41101 on both sides, and one other on one side, have the two canthals fused with each other, as in the *squamosus* section. Thus only 0.5% of *S. siniferus* would be misidentified if the fusion factor is used to supplement number of canthals.

Six specimens of S. *s. cupreus* from 25 mi E Oaxaca, Oaxaca (UCM 8971-6) have 11-14 femoral pores, typical of the subspecies.

Discussion

Yet accuracy of sorting is not by itself infallible as a clue to taxonomic status. *S. carinatus* is here still regarded as a distinct species, from *S. siniferus* , because the two populations are completely isolated from each other, as well as being almost invariably distinguishable, and maintain their integrity despite distributional gaps that exist in both. They are on separate evolutionary trajectories. Biologically they are probably best thought of as semispecies, but nomenclaturally as species. To treat them as subspecies would obscure their virtually complete morphological differentiation, their complete geographic separation, and the sharp distinction of the most closely approximated populations. Chiapas populations of *S. siniferus* , which are the closest geographically to *S. carinatus* , have fewer femoral pores than the latter species (4-6 in 45 specimens, vs. 8-13 in all eleven *S. carinatus* for which counts are available).

Actual sympatry of members of the *siniferus* group appears to occur only between *S. squamosus* and *S. siniferus* in the area around the southernmost common border of Chiapas and Guatemala, suggesting that these may be the least closely related species of the group.

Although all species of the *siniferus* group tend to have the paired postanals poorly developed in males, they are distinctly enlarged in occasional *S. s. siniferus* and *S. carinatus* (about 1 in 7), although in all *S. s. cupreus* examined.

The very short auricular lobules, extending no more than a third of the distance across the typanum, and being smaller than the preceding scales, are a group characteristic.

Key to Members of the *siniferus*

Group of *Sceloporus*

1. Two canthals, or if one, subnasal contacting lateral frontonasals...*siniferus* 2

   One canthal *and* subocular separated from lateral frontonasals 3

2. Femoral pores usually 9-14; postanals usually distinctly enlarged in males ....*s. cupreus*

   Femoral pores usually 3-8; postanals usually not distinctly enlarged in males ....*s. siniferus*

3. Femoral pores 3-6 ....*squamosus*

   Femoral pores 8-14 ....*carinatus*

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THE GENERIC STATUS OF THE SMOOTH GREEN SNAKE, *OPHEODRYS VERNALIS*

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Abstract

At least nine categorical distinctions exist between *O. aestivus* and *O. vernalis*. They are of such magnitude that a long separation from a common ancestor seems probable, in turn suggestive of different times of invasion of North America across the Bering Straits. *O. vernalis*, with its terrestrial habits and remarkably long egg-retention, gives evidence of a much greater ancestral episode of cold-adaptation than occurred in *O. aestivus*. In view of these extensive morphological and physiological differences, indicative of a long history of divergent evolution, the two species are properly regarded as generically distinct. *O. aestivus* is the type species of its genus, and we here erect the genus *Liochlorophis* for *O. vernalis*. Both genera are monotypic.

The affinities of the ten species of American and Asiatic snakes, currently recognized, that at one time or another have been referred to the nominal genus *Opheodrys* Fitzinger, 1843, have long been problematic, yielding only piecemeal to studies of separate components. The ten species are, in chronological order of their description:

1. *Coluber aestivus* Linné, 1766 (North America).
2. *Coluber vernalis* Harlan, 1827 (North America).
3. *Cyclophis major* Günther, 1858 (China).
4. *Eurypholis semicarinatus* Hallowell, 1861 (Riu Kiu Islands).
5. *Cyclophiops doriae* Boulenger, 1888 (China).
6. *Ablabes herminae* Boettger, 1895 (Riu Kiu Islands).
7. *Ablabes hamptoni* Boulenger, 1900 (Burma).
8. *Ablabes multicinctus* Roux, 1907 (China).

9. *Eurypholis mayae* Gaige, 1936 (Mexico).

10. *Liopeltis kikuzatoi* Okada and Takara, 1958 (Riu Kiu Islands).

The earliest modern review of all these species, as then known, appeared in Pope (1935), where all eight species then recognized, except *C. aestivus*, but including *C. vernalis*, were placed in the genus *Eurypholis* Hallowell (1860), whose type species, by monotypy, is *E. semicarinatus* of the same work. Presumably Pope regarded *C. aestivus* as the sole species of *Opheodrys*, although he did not so state. Generic separation of the two North American species was customary at the time (*Liopeltis vernalis* and *Opheodrys aestivus*) and until 1936, from the turn of the century through three editions of the Stejneger and Barbour checklists (1917, 1923, 1933), under the influence of Stejneger (1907). Pope (1935) merely added *C. vernalis* to the Asiatic species in one genus, *Eurypholis*.

Pope's arrangement only lasted a year, for unfortunately it was discovered (Schmidt and Necker, 1936) that *Eurypholis* Hallowell, 1860, is preoccupied by *Eurypholis* Pictet, 1850, for a genus of fossil fishes. Upon discarding *Eurypholis*, Schmidt and Necker decided, on the basis of weak keels in the Chinese species (intermediate between the strong keels of *O. aestivus* and smooth scales of *C. vernalis*) to lump all the Oriental, North American and Mexican species in *Opheodrys*, as the oldest available name, excluding only *C. doriae* and *A. hamptoni*, both placed in *Cyclophiops*, based on their entire anal (divided in all other eight species). Ever since Schmidt and Necker's work (1936), the two North American species have been treated as congeneric, in *Opheodrys*.

Not so the Oriental and Mexican species. *O. mayae* was the first to go, assigned by Rossman and Schaefer (1974) to the formerly monotypic genus *Symphimus* Cope, 1869. Then Cundall (1981) revived the name *Entechinus* Cope, 1895 (type *C. major*) for all of the remaining six species (*E. doriae*, *E. hamptoni*, *E. herminae*, *E. major*, *E. multicinctus*, *E. semicarinatus*), excluding *O. kikuzatoi*, which was not dealt with. Since material was not available to Cundall of half of these six species (*E. doriae*, *E. hamptoni*, *E. multicinctus*), they also were referred tentatively to *Entechinus*. That assignment appears to be well founded in view of the conclusions of M. Smith (1943) and Pope (1935), unless indeed revival of *Cyclophiops* is deemed justified in the future, as suggested by Schmidt and Necker (1936), for *E. doriae* and *E. hamptoni*.

Finally, Toyama (1983) conclusively disposed of *L. kikuzatoi*, which Koba et al. (1959) and others had referred to *Opheodrys*, by placing it in the genus *Opisthotropis* Günther, 1872.

All of these reallocations appear to be well founded, and leave only the two North American species in the genus *Opheodrys*. Elimination of the purported intermediacy of the keels of the Oriental taxa between the smoothly and strong keeled scales of the American species raises again, however, the question of the congeneric status of the latter. Indeed, the recognized authority on variation in both species, Arnold Grobman (pers. comm.) was long of the opinion that they were not congeneric, and once prepared a preliminary manuscript so proposing. Other matters intervened, however, and the ms. became buried and forgotten until recently when he sent it to us.

The Intrinsic Integumentary Muscles

Our own involvement arose incidental to a comparative study of the intrinsic integumentary muscles of snakes (Oldham and Smith, 1987 a, b, c) which in the "advanced" groups (Caenophidia, as commonly interpreted) are strictly limited to the ventral scales (they extend to various degrees onto the dorsal scales in the more primitive groups). These muscles have been little studied since the pioneer work by Buffa (1905), but our investigations reveal a remarkable phylogenetic conservativeness in their presence or absence among caenophidians, with, however, adaptive modifications evident in certain lines.

There are only six discrete, symmetrically paired intrinsic integumentary muscles on the ventral scales of caenophidian snakes, named by Buffa (1905) as follows: (1) *interscutales superficialis*, (2) *interscutales profundus*, (3) *scutales transversus*, (4) *scutales trapezoidales*, (5) *scutales ovales*, and (6) *scutales triangulari* (Fig. 1). These muscles serve important functions in moving and changing the shape of the ventral scales in ecdysis (individually freeing the shed skin as the snake crawls forward), in rectilinear locomotion (via movements of the ventral scales), and in climbing (via accentuation of ventrolateral ridges that aid in gripping non-horizontal surfaces).

The results of our comparative study of these muscles throughout snakes are not to be summarized here, but the discovery that *O. vernalis* possesses but three of the six pairs of muscles, whereas *O. aestivus* has five pairs, is of considerable interest. A more general review of the ophidian intrinsic integumentary muscles is in preparation by JCO.

In both species, the *scutales triangulari* are absent, as in most genera. On the other hand, both species possess the *i. superficialis*, *i. profundus* and *s. transversus* muscles. But the *s. trapezoidales* and *s. ovales* muscles are absent in *O. vernalis* (Fig. 2), present in *O. aestivus* (Fig. 1). The difference was confirmed by examination under magnification (binocular dissecting microscope) of skin sections removed from three areas along the trunk of seven preserved specimens of *O. vernalis*, four of *O. aestivus* (see appendix). The same procedure was followed in the study of other snakes.

Inasmuch as all caenophidians with enlarged ventrals (therefore excluding only some Hydropheidae and Acrochordidae) have the same three primitive muscles (*i. superficialis, i. profundus, s. transversus*) common to both species of *Opheodrys*, those three have no bearing on the relationships of the genus or its species. The other three muscles are specializations found only in Dowling's (1986) family Colubridae, but not in all members thereof. Dowling (1986) recognized 94 genera in the Colubridae, and we bring the total to 96 with the addition of *Entechinus* and *Dryadophis* (which he included in *Opheodrys* and *Mastigodryas*, respectively). Those 96 genera were assigned to five subfamilies (nine falling into Colubridae incertae sedis). We have examined 39 of those 96 genera, including 30 of the 51 in the subfamily Colubrinae, and 1-4 in each of the other subfamilies and the incertae sedis. Of these 39 genera, over two-thirds (28) lack the *s. triangulari;* mostly constrictors or heavy-bodied snakes (*Arizona, Cemophora, Coronella, Drymarchon, Elaphe, Lampropeltis, Phyllorhynchus, Pituophis, Pseustes, Rhinocheilus, Spilotes, Trimorphodon*) have them. Furthermore, in only two genera (*Lampropeltis, Phyllorhynchus*) are only the *s. ovales* muscles alone missing, of the three pairs, and in no genus are *s. trapezoidales* alone, or just two pairs, missing. In nine genera all three pairs are absent; *Entechinus, Ficimia, Opheodrys, Sonora, Stenorrhina, Stilosoma, Symphimus* (*mayae*), *Tantilla* and *Toluca*. In all cases, except *Opheodrys*, the species involved are strictly terrestrial, and some are burrowing.

In only three of these genera does intrageneric variation occur. In *Arizona elegans*, two subspecies (*expolita, philipi*) lack the *s. triangulari*, and one (*blanchardi*) possesses it. In *Lampropeltis*, one subspecies (*gentilis*) of *L. triangulum* lacks the *s. triangulari*, and two subspecies (*blanchardi, nelsoni*) of the same species possess them; furthermore, *L. calligaster* (both subspecies) lacks only the *s. ovales*. *L. getula* (*californiae, getula*) has all six pairs of muscles.

The significance of this variation in both *Arizona* and *Lampropeltis* merits investigation. In *Opheodrys*, however, all three specialized pairs are missing in *O. vernalis*, only the *s. triangulari* in *O. aestivus*. In no other genus did we find such an extensive difference among its species; it is no doubt linked to the difference in behavior in the two species, one (*O. vernalis*) retaining a more primitive versatility, being basically terrestrial with no specialization for arboreality or constriction, the other (*O. aestivus*) having evolved adaptations for extensive arboreality.

The absence of all three muscles in *Entechinus*, *O. vernalis* and *S. mayae* - all sufficiently similar in other ways to have long been considered congeneric even in recent times - merely indicates common retention of an unspecialized, ancestral condition. Only in *O. aestivus*, of the group in question, have the three primitive pairs of muscles become differentiated for performance of specialized functions - in this case arboreal locomotion.

In our opinion the difference in the intrinsic integumentary muscles of the two species of *Opheodrys* is a major one, not known to be duplicated in any other genus. It warrants examination of other possible evidence of separate generic status of the two species.

Egg Retention

Of equally great phyletic significance, in our opinion, is the remarkable disparity in duration of postdepositional fetal development. In *O. aestivus* the range is 44-67 days (e.g. Minton, 1972; McCauley, 1945); it is a non-egg-retainer. *O. vernalis*, on the contrary, is recorded with an incubation period as short as four days (Blanchard, 1923), and a range of 4 -23 days in northern Michigan. It is an extreme egg-retainer; no other reptiles in North America come close to such a short incubation period. (Peterson's 1956 report on viviparity in *Diadophis p. punctatus*, occurring May 21, is, we suggest, referable to *Storeria occipitomaculata* with erroneous locality data (Miami, Florida); Ashton (1981) notes that birth in the latter species occurs in spring. In the absence of confirmatory evidence of viviparity in the former species, the 1956 report should remain questionable.) Indeed, Blanchard (1933) observed that "The possibility of occasional ovoviviparity in this species is suggested by this very brief interval," and Shine (1985) regarded the egg retention as so protracted as to be physiologically equivalent to viviparity. A number of workers has confirmed the short incubation period in several areas, and an anecdotal possibility of viviparity has been recorded (Minton, 1972). Nevertheless, the brevity of incubation is apparently geographically variable, because incubation times in the Chicago area (Stille, 1954) and in central Illinois (Smith, 1961) are about 30 days. If viviparity actually ever occurs in the species, it might be most likely in extreme northern populations. Many more data are necessary to clarify the variation that may exist in the species in this context, particularly in the west, southwest and northeast. It will be of considerable importance to determine the geographic variation in life history of this species because of its wide distribution under highly diverse environmental conditions, and its documented protracted egg retention in at least part of its range.

Many lizards that appear to have evolved viviparity relatively recently (as suggested by its failure to occur throughout genera or major species groups in which some but not all species are vivparous) have shifted from spring to fall fertilization (ovulation following an earlier, summer or fall mating), so that development proceeds through winter (Méndez et al., 1988). It would be of great interest to compare *O. aestivus* and *O. vernalis* in that context.

The origin of near-vivparity in *O. vernalis* is very likely a product of cold adaptation (thermoregulating embryonic development), which is the foremost factor involved in evolution of reptilian viviparity (e.g. Shine, 1985). Whether it is a long-standing adaptation (i.e. appearing prior to ancestral migration from Asia) or has evolved more or less in situ is problematical. Since reversal of egg-retention is commonly regarded as unlikely, as would be the case in southern populations had that adaptation appeared premigratorially, it would seem to have evolved in North America.

Nevertheless, *O. aestivus*, with its five pairs of skin muscles and southern range, very likely evolved from an earlier intercontinental migration than *O. vernalis*, which for unknown reasons, possibly competition, has a range complementary with that of *O. aestivus* in eastern United States, the latter species occurring to the south. Toward the southwest, however, *O. vernalis* reaches northern Chihuahua (albeit in mountains), where no such competition exists. It is likely that *O. vernalis* evolved later from an ancestral Asiatic population that retained the three primitive pairs of ventral muscles, as suggested by that shared plesiomorphy with *Entechinus*. The southern distribution of *O. aestivus* and its unique (in its group) muscular apomorphy suggest a much earlier intercontinental migration from ancestral Asiatic stock. Its muscular apomorphy probable evolved postmigratorially.

Other Major Disparities

In addition to these two particular, fundamental differences that bespeak a long-independent history of phylogeny, at least seven other trenchant differences exist, as follows.

3. Scale rows. *O. vernalis* has 15, *O. aestivus* 17.

4. Keels. *O. vernalis* is completely smooth-scaled, whereas *O. aestivus* has the eleven median scale rows distinctly keeled.

5. Apical pits. O. vernalis has one apical pit on the dorsal scales, *O. aestivus* has two.

6. Subcaudal scales. *O. vernalis* has 60-102 (Grobman, 1941; McCauley, 1945; Conant, 1951), *O. aestivus* 105-159 (Grobman, 1984).

7. Hemipenis. Rossman and Schaefer (1974) noted that the everted hemipenis of *O. vernalis* is less elongate than in *O. aestivus*, has fewer spines, a larger circular nude area apically, and fewer although larger and deeper calyces. Most of these differences are evident in comparison of the figures of the hemipenis of both species in Cope (1895: pl. 19, fig. 3, pl. 21, fig. 4).

8. Frontal-rostral proportion. The median length from frontal to rostral (muzzle) is short (58% of frontal length) in *O. vernalis*, long (74%) in *O. aestivus* (Rossman and Schaefer, 1974).

9. Habits. *O. vernalis* largely terrestrial, seldom found climbing into bushes, whereas *O. aestivus* is strongly arboreal. Numerous field studies and incidental observations document this difference (e.g. Cochran, 1987; Goldsmith, 1984; Plummer, 1989), and the longer tail of *O. aestivus* (reflected in its more numerous subcaudals) is adaptive to its arboreality. In addition, as expounded by Clark (1967), long-tailed snakes, adapted for arboreality, tend strongly to have less sexual dimorphism in tail length (and subcaudal counts) than do short-tailed snakes. This difference is evident in the coefficients of divergence in tail lengths of male and female *O. vernalis* (.15), nearly twice as great as in *O. aestivus* (.09). The body of the latter species is proportionally more slender than in *O. vernalis*, and its total length is greater (847 vs. 650 mm respectively; Rossman and Schaefer, 1974). All of these morphological distinctions are correlated with the difference in preferred habitat: arboreal in one (*O. aestivus*), terrestrial in the other.

Non-Categorical Differences

1. Tooth counts. Rossman and Schaefer (1974) noted that, in conjunction with its longer head, reflected by its longer muzzle, *O. aestivus* has more teeth on all dentigerous bones than *O. vernalis*, although the counts overlap in the two species on all bones. Range and mean for maxillary, dentary, palatine and pterygoid teeth in *O. vernalis* and *O. aestivus*, respectively, given by them are: 16-21 $\bar{x}$ 18, 19-24 $\bar{x}$ 22; 18-23 $\bar{x}$ 20, 22-26 $\bar{x}$ 24; 11-15 $\bar{x}$ 13, 12-17 $\bar{x}$ 13; 14-17 $\bar{x}$ 15, 14-18 $\bar{x}$ 16.

2. Ventrals. *O. vernalis* generally has fewer ventrals than *O. aestivus*, with a total range in both sexes of 116-154 in the former (Grobman, 1941) and 144-171 in the latter (Grobman, 1984). The overlap, however, is restricted to females, 121-154 in the former, 145-171 in

the latter. Male *O. vernalis* have 116-141, O. aestivus 144-168, hence without overlap.

Discussion

In view of the remarkable disparity between *O. vernalis* and *O. aestivus* in phyletically important features indicative of long independent phylogeny, and of a magnitude consistent with differences between other related genera; and because of the absence of intermediacy of any congeneric taxa as now understood, these two species are best represented in classification by separate genera, as suggested by Oldham and Smith (1987b).

The generic name *Opheodrys* has as its type species *Coluber aestivus* Linné, which perforce is properly designated as *O. aestivus*. However, no generic name is available for *Coluber vernalis* Harlan, for which we propose

Liochlorophis gen. nov.

Diagnosis. A member of the family Colubridae, subfamily Colubrinae, tribe Colubrini as of Dowling (1986), having all character states defining those taxa; of the six pairs of intrinsic integumentary muscles of the ventral plates occurring in that family, three are missing (*scutales triangulari, s. trapezoidales, s. ovales*); protracted egg retention, with a maximum postdepostional fetal period of about 30 days; 15 scale rows; no vestige of keels on dorsal scales; one apical pit; subcaudal scales 60-102; hemipenis relatively short, with relatively few spines and calyces but a relatively large apical nude area; muzzle relatively short, about 58% of frontal length; mostly terrestrial in habitat, with a maximum total length of 650 mm, a relatively short tail with distinct sexual dimorphism in both length and number of subcaudals; males with 116-141 subcaudals, anal divided; color uniform grass-green above, white or light yellow below in adults, young "dark olive-gray above, lighter on the sides,and pale grayish blue below" (Blanchard, 1933). Occasional aberrant individuals are buff or tan.

Species. One, the type, *Coluber vernalis* Harlan, 1827. Two subspecies are recognized: *Liochlorophis v. vernalis* (Harlan), and *L. v. blanchardi* (Grobman). One other is in press (Grobman, pers. comm.).

Remarks. The various combinations in which the specific name *vernalis* has appeared are summarized by Grobman (1941).

The generic name *Liochlorophis* is a combination of Greek words - *lio, chloro* and *ophis* - meaning, respectively, smooth, green, snake.

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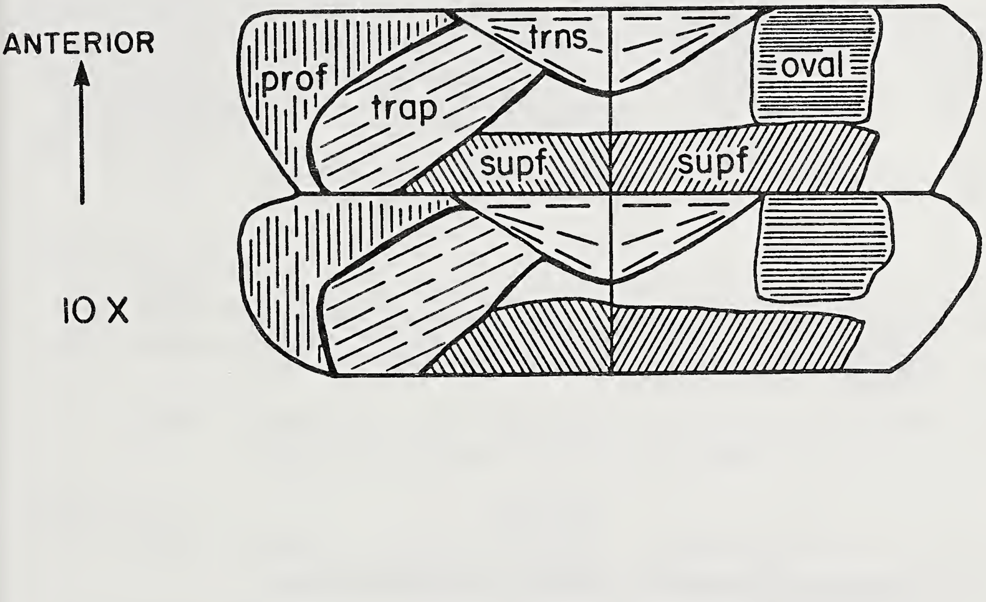

Fig. 1. Dorsal view of the intrinsic integumentary muscles of *Opheodrys aestivus*, from UCM 13611. Symbols: *prof*, interscutales profundis; *supf*, interscutales superficialis; *oval*, scutales ovales; *trns*, scutales transversus; *trap*, scutales trapezoidales. The deeper muscles, shown on the left side, are removed on the right.

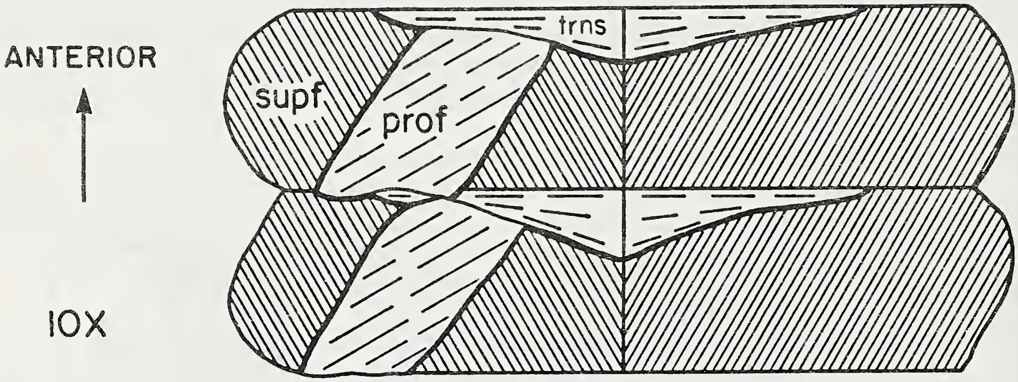

Fig. 2. Dorsal view of the intrinsic integumentary muscles of *Liochlorophis vernalis*, from UCM 51881. Symbols as in Fig. 1. Deeper muscles shown on left, removed on right.

Appendix

Specimens Examined of "*Opheodrys*" *auctorum*.

O. aestivus: UCM (Univ. Colorado Mus.) 13611, from Eldorado, Union Co., Arkansas; UCM 35873, from 1 mi SE Lanexa, New Kent Co., Virginia; and two uncataloged MS (Metropolitan State College of Denver) specimens from unknown localities.

L. vernalis: UCM 39551, from 9 mi N Rochford, Pennington Co., South Dakota; UCM 51881, from 10 mi downstream on Dolores River from Dolores, Montezuma Co., Colorado; and five MS specimens from unknown localities.

E. herminae: KUZ (Kyoto Univ. Dept. Zool.) 13000, from Kuroshima Island, Okinawa, Japan.

E. major: KUZ 9693, from Zaolin, Nantou, Taiwan.

E. semicarinatus: KUZ 13001-2, from Kumejima Island, Okinawa, Japan.

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*To the great sorrow of his friends, colleagues and students, Dr. Jonathan Clark Oldham died suddenly at his home, Nov. 21, 1991, age 52.

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RANGE EXTENSIONS OF THREE REPTILE SPECIES IN NORTHERN MEXICO

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Abstract

Phrynosoma orbiculare orientale is recorded from Coahuila, *Cnemidophorus inornatus paululus* from San Luis Potosí, and *Heterodon nasicus kennerlyi* from Nuevo León.

While conducting field work in Mexico from 1969 to 1971, in pursuit of his doctoral dissertation on the classification of lizards allied to *Sceloporus*, Dr. William P. Hall incidentally collected other herps, among which are three notable range extensions or state records, here reported. Voucher specimens are all in the Museum of Comparative Zoology (MCZ).

Phrynosoma orbiculare orientale Horowitz. As noted by Pianka and Smith (1959: 120), Horowitz (1955: 215) had no record of *P. orbiculare* from Coahuila; Pianka and Smith recorded it from a locality east of Saltillo, near the Nuevo León border. A second locality of record in the state, south of Saltillo near the Zacatecas border, is provided by a single adult female (MCZ 134035, 90 mm sv) taken 37 km S Saltillo (23 km N of road to Gomez Farias, on Hwy. 54), at the bottom of the hill just NW of Carneros. It has 27 femoral pores and 30-31 fringe spines, HW/HL ratio 12.5, TL/BL ratio .578, Occ/BL ratio 0.56. These features agree adequately with the characteristics of *P. o. orientale* as defined by Horowitz.

Cnemidophorus inornatus paululus Williams. When Williams (1968) described *C. i. paululus* no specimens of the species were available from the state of San Luis Potosí, and none referred to that subspecies has been reported since then. A single subadult female (MCZ 127363), 51 mm sv, taken 10.5 km N Moctezuma (between Charcas and Ahualulco) (or 31.5 km S, 1 km W Charcas), San Luis Potosí, el. 1800 m, documents existence of the subspecies at least in the central part of the state; it no doubt occurs throughout most of the northern half. The specimen agrees in full with the diagnostic features of *C. i. paululus*, having 8 light stripes on a very dark brown background, little lighter between paravertebral stripes; venter pale blue throughout; 64 scales around midbody; femoral pores 19-19.

The range extension from previously recorded marginal records in Coahuila and Zacatecas is about 150 km.

The specimen contained in the pleuroperitoneal cavity several hundred small cysticercoids. Dr. O. Wilford Olsen kindly examined them and indicated that they could not be identified with certainly, but "that they definitely are not taenioid worms, nor *Mesocestoides.* They could be snake parasites of the genus *Oochoristica.*"

A second specimen of *Cnemidophorus* from this locality, and another from 10 km N Ahualulco, both possibly of the same species as MCZ 127363, was given to the museum of the Escuela de Ciencias Biológicas of the Universidad de Nuevo León.

Cole et al. (1988: 8) reported the species from 9.3 rd km NW Arista, and 15.4 km NE San Luis Potosí, in the state of San Luis Potosí. Presumably *C. i. paululus* is represented by the specimens recorded, and if so its known range is extended another 60-65 km south of the locality here recorded, near the southern limit of favorable habitat.

Heterodon nasicus kennerlyi Kennicott. Although the geographic range of this race has long been known to encompass the state of Nuevo León, no previous records exist for it. An adult female (MCZ 154338) found about 5 km ENE General Bravo on Hwy 40, documents occurrence of the species in that state. It measures 512 mm in total length, tail 55 mm. The scale rows are 23-19, ventrals 142, caudals 29 (nos. 26-28 undivided), three accessory scales to the azygous scale between prefrontals. The specimen is typical of its subspecies in the diagnostic character of the low number of accessory scales, and differs markedly from other subspecies in its pale color; the dorsal blotches are dim and scarcely or not at all larger than the lateral blotches, which are much better defined than the middorsal ones. It is uncertain whether the faded pattern is characteristic of the subspecies or is an individual variation; it is markedly different from the sharply defined pattern of the other subspecies.

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Environmental, Population and Organismic Biology, University of Colorado,
Boulder,Colorado, 80309-0334.

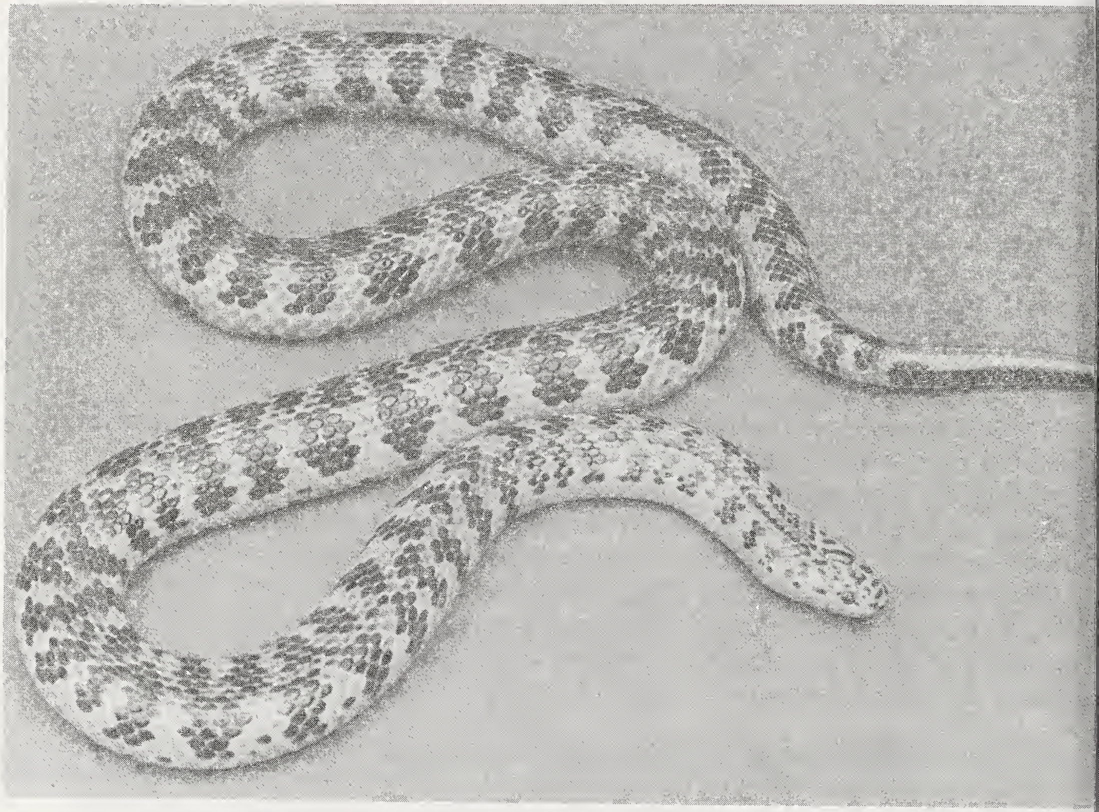
Received: 26 April 1991
Accepted: 30 April 1991

AN ABERRANTLY MARKED *FARANCIA ABACURA* FROM SOUTH CAROLINA

On April 14, 1991, an aberrantly marked specimen of *Farancia abacura* was collected by one of the authors (SCE) at ca. 2000 hours while crossing a secondary road in Kershaw county, South Carolina. Normal coloration for this species has been described by Behler and King (1979) as a "shiny blue-black snake with pink or red belly bars extending upward on sides". Wright and Wright (1957) describe two specimens of *F. abacura* in which the ventral coloration was white. also mentioned was a partial erythristic individual described by Etheridge (1950). This animal displayed "a black line for 1/3 length anteriorly, followed by a shorter line posteriorly. The rear half had transverse dorsal bands. The interspaces were red".

The specimen collected in Kershaw County lacked much of the black dorsal coloration found in normal examples of this species. Instead, the sides of the body and dorsum displayed a pink coloration, the only exception being an irregular zig-zag pattern extending down the anterior half of the dorsum. This pattern became transverse dorsal bands posteriorly, as in the Etheridge (1950) specimen (Fig. 1). The ventral surface lacked any dark pigmentation. Ground color of the head was yellow and exhibited faded dark spots on the upper labials, as well as more pronounced markings on the head shields. The specimen, a male, measured 95 cm. at the time of capture.

Scalation also proved to be slightly aberrant. the snake possessed a divided anal plate, followed by four rows of undivided caudals. The remaining 30 rows of caudals were divided. The specimen is currently housed in the private collection of SCE. Upon death, it will be deposited in the Vertebrate Collection of the south Carolina State Museum. Inquiries regarding specific locality data should be addressed to SCE.



—*Chuck Smith*, Carolina Herpetological Studies, 116 Forest Drive, Gaston, South Carolina, 29053

—*Steve Emery*, Riverbanks Zoological Park, P. O. Box 1060, Columbia, South Carolina, 29202.

Received: 1 May 1991
Accepted: 5 May 1991

NEW BOOKS:

The University of Kansas Museum of Natural History

Prepublication Announcement

REPRODUCTIVE CYCLES IN LIZARDS AND SNAKES

Henry S. Fitch

A limited second printing of this long out-of-print classic is being offered at a special pre-publication price. Fitch's book, originally issued in 1970, is the standard compendium and reference worldwide to reproductive cycles, egg clutches and litter sizes, and incubation periods for worm-lizards, lizards, and snakes. Information for this book was accumulated through decades of direct observation and detailed literature search, and represents a wealth of information available nowhere else. In addition to species accounts, which make up the major portion, this book contains sections on factors affecting reproductive cycles, brood sizes, timing of breeding season, and a discussion of viviparity versus oviparity. The concluding Literature Cited, with over 525 references, is an excellent survey of the subject. 247 pages. ISBN 0-89338-037-7.

Prepublication price	*$19.95*
After July 15, 1991	*$29.95*

Please add $2.00 postage & handling for the first copy, $.50 for each additional copy. For Kansas delivery add 5.25% sales tax.

Send orders, accompanied by payment, to Publications, Museum of Natural History, 602 Dyche Hall, The University of Kansas, Lawrence, Kansas 66045-2454 USA. MasterCard or VISA orders may be placed by telephone (913) 864-4540 or FAX (913) 864-5335
A complete list of our herpetological publications is available on request.

NEW BOOKS:

TWO NEW BOOKS ON MIDDLE EAST HERPETOLOGY

• *from the Society for the Study of Amphibians and Reptiles* •

THE SNAKES OF IRAN by Mahmoud Latifi

English translation of 1985 edition in Farsi, covering biology, venoms, and snake bite and its treatment. Descriptive account with information on size, diet, reproduction, habitat, and distribution for each species. Key to the 60 species of Iranian snakes, a list (by province) of distribution in Iran, and an extensive bibliography. The 24 color plates include two maps and 22 plates of snakes (66 figures) with range maps. New appendix by Alan Leviton and George Zug contains supplemental bibliography and current nomenclature.

Specifications: 164 pages, 24 color plates, 2 maps, 25 figures (8 photos), 6 x 9 inches, $22 clothbound and postpaid in USA. **Now published!**

HERPETOFAUNA OF IRAQ, KUWAIT, AND THE ARABIAN GULF REGION

by Alan E. Leviton, Steven C. Anderson, Sherman A. Minton, and Kraig Adler

Handbook for identification of amphibians and reptiles of region extending from Turkish border through Iraq, Kuwait, and northern and eastern Saudi Arabia, including the Arabian (Persian) Gulf and lowlands bordering it (southwestern Iran, Bahrain, Qatar, and United Arab Emirates). Book contains checklist of 144 species and subspecies, including diagnosis and distribution, and an illustrated key. The 32 color plates (210 photos) depict every genus and most species. Separate chapter on venomous snakes with section on venoms and treatment. Extensive bibliography of Middle East herpetology and appendix by John E. Simmons on collecting and preservation techniques.

Specifications: About 175 pages, 32 color plates, many maps and text figures, 7 x 10 inches, $28 clothbound and postpaid in USA. To be published shortly.

Send Orders To: Robert D. Aldridge, Department of Biology, St. Louis University, St. Louis, Missouri 63103, USA. Make checks payable to "SSAR." Overseas postage extra.

SSAR membership details are available on request to Dr. Aldridge.

NEWS & NOTES

American Federation Of Herpetoculturists

The American Federation of Herpetoculturists (AFH) is a non-profit national organization whose purpose is to represent the interests of herpetoculturists, those individuals involved with the captive husbandry and propagation of amphibians and reptiles. A primary goal of the AFH is to help implement sound legislative regulations that protect the rights of herpetoculturists to practice their avocation in a responsible manner while considering the welfare of amphibian and reptiles, and of the general public.

Another goal of the AFH is the dissemination of information related to herpetoculture among private herpetoculturists, herpetological societies, zoos, veterinarians, research institutions, the pet industry, and the general public. This will be accomplished through *The Vivarium*, the official publication of the AFH, the first high quality national herpetocultural journal to document the accomplishments of herpetoculturists and to promote a general philosophy of herpetoculture whereby captive propagation can contribute to the conservation of biological diversity.

Yearly Membership Rates

Individual	$26.00
Foreign Country Membership	$32.00 - **all membership dues must be paid in U.S. dollars - a check must be drawn on a U.S. bank.**
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Membership in the AFH will entitle you to the following:

1. One year membership in the American Federation of Herpetoculturist. The only national society that represents the herpetoculturist.
2. Six issues of *The Vivarium*, a high quality 8 1/2" x 11" publication. Each issue contains information on captive care, propagation, legislation, books, medical, natural history, products, techniques, etc..
3. Special discounts on AFH sponsored programs and events.

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NEWS & NOTES

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ORANGE COUNTY, CALIFORNIA

AT LAST A T-SHIRT THAT REALLY EXPRESSES YOUR INTEREST IN REPTILES, WITH A VIVID 10 COLOR ILLUSTRATION OF 16 ASSORTED REPTILES, AMPHIBIANS & ARACHNIDS ON 100% WHITE COTTON. SIZES M,LG,XLG,XXLG. $15 + $2.50 S/H
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NEWS & NOTES

GET SERIOUS

and use the products more zoos and professional hobbyist use . . .

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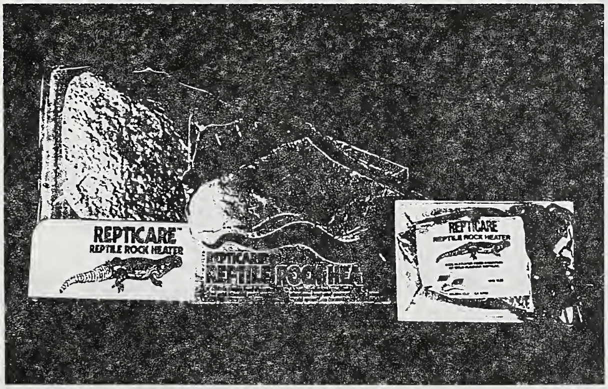
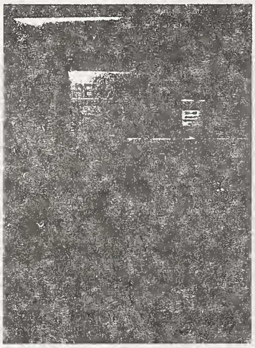
Santa Ana, Ca 92705



REPTICARE REPTILE ROCK HEATER
The finest reptile rock heater on the market. Designed to aid in proper food digestion of cold blooded reptiles. All three sizes made with multiple heating elements to **prevent** "hot spots" on the rock surface. A high grade cement used to prevent "pitting" on rock surface which can lead to harmful bacteria buildups. More surface area on the standard and giant sizes than the leading competition. Natural looking, molded from a rock!

Catalog number	Size	Application
RH-1	standard	10-30 gallon terrarium size
RH-2	mini	5 gallon terrarium size
RH-3	giant	40-100 gallon terrarium size

NEWS & NOTES:



REPTI-THERM U.T.H.

Designed as an alternative or complement to the Repticare Reptile Rock Heater. All four sizes are designed to heat your terrarium 10°F warmer than outside ambient air temperature (when using a screen top) or 15-20°F warmer when using a glass top. If your terrarium is in a particularly cold area (60-65°F) and you are keeping tropical type reptiles (minimum 80- 85°F) you may need both a Repti-Therm U.T.H. **and** a Repticare Reptile Rock Heater to **increase** your ambient terrarium temperature by 20°F. The Repti-Therm U.T.H. is also recommended for amphibian or turtle terrariums.

Catalog number	Size/Application
RH-4	10-20 gallon terrarium
RH-5	30-40 gallon terrarium
RH-6	50-60 gallon terrarium
RH-7	For small plastic terrariums on up to 5 gallon glass terrariums

REPTILE VINES

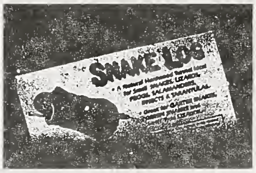
Natural grapevine wood for your terrarium. Adds a feeling of "well being" for your animals while helping to induce normal feeding behavior. Safe for all reptiles, amphibians, mice, rats and hamsters.

Catalog number	Size
CF4-S	small/6"
CF4-M	medium/8-10"
CF4-L	large/12-16"
CF4-X	x-large/18-24

HIGH RANGE REPTILE THERMOMETER

An "easy to read" **high range** liquid crystal reptile thermometer. Adhesive backing allows thermometer to be placed on inside back wall of terrarium for an accurate ambient air temperature reading. Range from 70°F to 105°F. Can also be used for Discus fish or when medicating tropical fish.

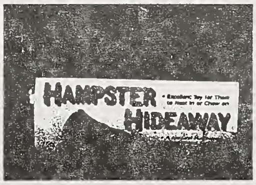
Catalog number	Size	Application
TH-10	70-105°F	For up to a 40 gallon size terrarium Use one at each end for larger size terrariums



SNAKE LOG

A natural hardwood tunnel ideal for small snakes, lizards, frogs, salamanders, insects & tarantulas.

Catalog number	Size
CF7-S	regular



HAMSTER HIDEAWAY

A natural hardwood tunnel ideal for hamsters, mice and gerbils. Excellent toy for them to nest in or chew on.

Catalog number	Size
CF7-H	regular

HABBA TREE

Completely natural wood and moss piece of "Cage Furniture" that will give your bird or reptile a place to hide or play. Provides a sense of security for your pet birds or reptiles while helping to ease stress associated with captivity. Adds to the beauty of your terrarium or bird cage. Safe for all birds-excellent toy for them to chew on.

Catalog number	Size
CF5-R	regular/8-12" tall
CF5-S	select/15-18"tall

BIRD VINES

Natural grapevine wood for your pet birds. Provides a sense of security for your pet birds while helping to ease stress associated with captivity. Safe for all birds-excellent toy for them to chew on.

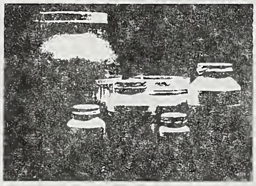
Catalog number	Size
CF6-S	small/6"
CF6-M	medium/8-10"
CF6-L	large/12-16"
CF6-X	x-large/18-24"

DRIFTWOOD

Freshwater collected so no tannic acid. Safe for freshwater or saltwater aquariums and reptile or rodent terrariums. Half the price of expensive Malaysian driftwood.

Catalog number	Size
CF1-S	small/6"
CF1-M	medium/8"
CF1-L	large/12"
CF1-X	x-large 14-18"

NEWS & NOTES:



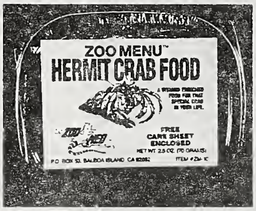
AVIAN® PLUS

The best **value** bird vitamin for your money.

Advantages:

- Calcium based-helps in bird breeding programs where high calcium is needed.
- No fillers-like yeast, soy or sugar.
- Concentrated and economical-with "human grade" vitamins and minerals so you use less vitamin powder, less often.
- Isolated amino acids-the only bird vitamin to use 16 isolated amino acids for improved bird digestion.
- Finer milling-for maximum adhesion to seed.
- Orange flavoring-for bird appeal. No "vitamin" smell.
- No preservatives-like liquid vitamins which could increase bird respiration.

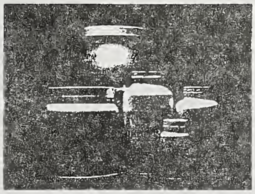
Catalog number	Size	Application
A37-1	1 oz.	New birds sprinkle small amounts on food daily for first two weeks Established birds: Use on 2-3 feedings per week.
A37-4	4 oz.	
A37-8	8 oz	
A37-16	16 oz	
A37-40	2 1/2 lb.	
A37-80	5 lb.	



HERMIT CRAB FOOD

- A high protein dried pellet containing fish meal, shrimp meal, marine plant matter and added vitamins and minerals.
- Hermit crab "care sheet" included.

Catalog number	Size	Application
ZM-10	2.5 oz	1 package will feed 6 small hermit crabs for 2-3 weeks.



REPTIVITE® REPTILE VITAMINS

The best **value** reptile vitamin for your money. Currently used by major reptile zoos and hobbyists worldwide.

Advantages:

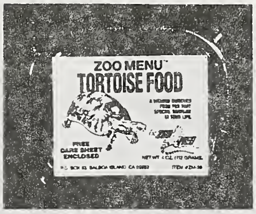
- Calcium based-no need to buy an "additional" calcium supplement.
- No fillers- calcium based with human grade vitamins and minerals means we do not use any cheap soy, yeast or sugar (sucrose) to "fill" our product up.
- Isolated amino acids-the only reptile vitamin that uses 16 isolated amino acids for better protein digestion in your animals.
- Insures healthy bone growth, aids in better circulation, protects metabolic functions, helps in skin shedding, prevents rickets and aids in prevention of liver problems.

Catalog number	Size	Application
A36-2	2 oz.	Use daily on new animals for two weeks then every other feeding Dust lightly over vegetables,fruits, or turtle foods. "Shake" on crickets (in a plastic bag) or wet fur on rodent and sprinkle on wet fur.
A36-8	8 oz.	
A36-16	16 oz	
A36-40	2 1/2 lb.	
A36-80	5 lb.	

REPTI-CRICKET

- First product of its' kind on the market (6 months in testing)! A vitamin enriched flavor enhanced, dried cricket. Simply open container and lightly mist dried crickets with water and your lizards or frogs will start feeding within 5-10 minutes.
- Excellent "vacation food" if you go out of town and leave your animals in the hands of a "lizard sitter."
- Can also be used for aquatic turtles.

Catalog number	Size	Application
ZM-40	5/8 oz	1 package will feed up to 4 medium sized lizards for 1 week



ZOO MENU TORTOISE FOOD

- Product based on peas, also contains apples, carrots and added vitamins and minerals.
- Can also be used on Green Iguanas as well as other "omnivorous" feeding type lizards (i.e. Amevias, Lacertas, etc.).
- Tortoise "care sheet" included.

Catalog number	Size	Application
ZM-30	5 oz	Good for 2-3 feedings per small (4-6") tortoise

AQUATIC TURTLE FOOD

- A low protein, floating pellet type food containing wheat flour, soybean meal, fish meal and added vitamins and minerals. A low protein diet helps prevent shell deformities in aquatic turtles.
- Two sizes available.
- Aquatic turtle "care sheet" included.

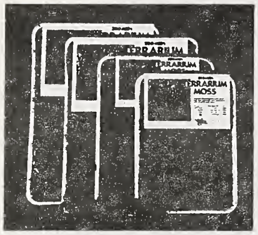
Catalog number	Size	Application
ZM-50	2 oz.	2 oz package will last 3-4 feedings per turtle
ZM-55	11 oz.	

ZOO MENU BOX TURTLE FOOD

- Product based on corn-a box turtles favorite food. Also contains apples, carrots and added vitamins and minerals.
- Box turtle "care sheet" included.

Catalog number	Size	Application
ZM-20	5 oz	Good for 3-4 feedings per box turtle

NEWS & NOTES:



TERRARIUM MOSS

Completely natural sphagnum moss for use with frogs, toads, salamanders, green snakes and all other moss environment species.

Catalog number	Size
CF2-S	5 gallon size
CF2-M	10 gallon size
CF2-L	15/20 gallon size
CF2-X	30/40 gallon size
CF2-B	Bale/commercial size

LOG CABIN TERRARIUM

Natural, hand made, "Desk Top Terrarium" ideal for hermit crabs, salamanders, tarantulas and small lizards. Comes complete with 8 page instruction book and moss package. X-large size complete with light/hood.

Catalog number	Size
LCTS	small/6" tall
LCTM	medium/7" tall
LCTL	large/8" tall
LCTX	x-large 10-12" tall

DESERT TERRARIUM TREES

A completely natural piece of dried and cleaned cholla cactus. Adds to the beauty of your terrarium while helping to enable normal feeding, mating and sleeping behavior.

Catalog number	Size
CF3-R	regular/6"
CF3-B	big/12"
CF3-G	gigantic/16"

POSTERS

Zoo Med's "Reptiles of the World" poster with 128 photo illustrations has sold over 25,000 copies worldwide.

Catalog number	Title
P101	Reptiles of the World
•P102	Turtles of the World
•P103	African Cichlid Fishes
•P104	Cage and Aviary Birds
HC101	Red Eye Treefrog
HC102	New Caledonia Gecko
HC103	Fischer's Chameleon
HC104	Prehensile Tail Skink
HC105	White's Tree Frog
HC106	Parson's Chameleon
HC107	Emerald Tree Boa
HC108	Mangrove Snake

•Due out winter/spring 1991

HC101

HC102

HC103

HC104

HC105

HC106

HC107

HC108

NEWS & NOTES:

WANTED: *Python regious* information. Anyone with information concerning *Python regius* (bell python). Please write or call for a survey information packet. Greg Greer, Chattahoochee Nature Center, 9135 Willeo Rd., Roswell, Georgia, 30075, U.S.A. day (404) 992-2055 night (404)952-3737.

WANT TO BREED SNAKES BUT ONLY HAVE ONE?

Join the United States' only Cooperative Breeding Coordination Program! Network with others in your state that own snakes of the opposite sex! For free information send a SASE to Snake Charmer, Dept. CBCP, P.O. Box 385, Dearborn Heights, MI 48127.

NOTES:

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Society Publication

Back issues of the Bulletin of the Maryland Herpetological Society, where available, may be obtained by writing the Executive Editor. A list of available issues will be sent upon request. Individual numbers in stock are $2.00 each, unless otherwise noted.

The Society also publishes a Newsletter on a somewhat irregular basis. These are distributed to the membership free of charge. Also published are Maryland Herpetofauna Leaflets and these are available at $.25/page.

Information for Authors

All correspondence should be addressed to the Executive Editor. Manuscripts being submitted for publication should be typewritten (double spaced) on good quality 8 1/2 by 11 inch paper with adequate margins. Submit original and first carbon, retaining the second carbon. If entered on a word processor, also submit diskette and note word processor and operating system used. Indicate where illustrations or photographs are to appear in text. Cite all literature used at end in alphabetical order by author.

Major papers are those over 5 pages (double spaced, elite type) and must include an abstract. The authors name should be centered under the title, and the address is to follow the Literature Cited. Minor papers are those papers with fewer than 5 pages. Author's name is to be placed at end of paper (see recent issue). For additional information see *Style Manual for Biological Journals* (1964), American Institute of Biological Sciences, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016.

Reprints are available at $.03 a page and should be ordered when manuscripts are submitted or when proofs are returned. Minimum order is 100 reprints. Either edited manuscript or proof will be returned to author for approval or correction. The author will be responsible for all corrections to proof, and must return proof preferably within 7 days.

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